

Site:	Industrialex
Break:	0.4
Other:	33650

Section 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 Description of Work

Furnish and install the cast-in-place concrete as shown and indicated on the Drawings and as specified in this Section, complete.

1.02 Referenced Publications

(a) The latest edition of the publications listed below form a part of these Specifications:

1. American Concrete Institute (ACI)  
Publications
  - 211.1 Standard Practice for  
Selecting Proportions for  
Normal, Heavyweight, and Mass  
Concrete
  - 301 Specifications for Structural  
Concrete for Buildings
  - 302.1R Guide for Concrete Floor and  
Slab Construction
  - 304 Recommended Practice for  
Measuring, Mixing, Trans-  
porting, and Placing Concrete
  - 305R Hot Weather Concreting
  - 306R Cold Weather Concreting
  - 318 Building Code Requirements for  
Reinforced Concrete
2. U.S. Army Corps of Engineers (COE) Waterways  
Experiment Station Publications

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- CRD-C-621      Handbook for Concrete and  
Cement, Specifications for  
Non-shrink Grout, Volume II
3.    American Association of State Highway and  
Transportation Officials (AASHTO) Publication
- M 182      Burlap Cloth Made From Jute or  
Kenaf
4.    American Society for Testing and Materials  
(ASTM) Publications
- C 31      Making and Curing Concrete  
Test Specimens in the Field
- C 33      Concrete Aggregates
- C 39      Compressive Strength of  
Cylindrical Concrete Specimens
- C 42      Obtaining and Testing Drilled  
Cores and Sawed Beams of  
Concrete
- C 94      Ready-Mixed Concrete
- C 143      Slump of Portland Cement  
Concrete
- C 150      Portland Cement
- C 171      Sheet Materials for Curing  
Concrete
- C 172      Sampling Freshly Mixed  
Concrete
- C 173      Air Content of Freshly Mixed  
Concrete by the Volumetric  
Method
- C 231      Air Content of Freshly Mixed  
Concrete by the Pressure  
Method
- C 260      Air-Entraining Admixtures for  
Concrete
- C 309      Liquid Membrane-Forming  
Compounds for Curing Concrete
- C 494      Chemical Admixtures for  
Concrete

C 595	Blended Hydraulic Cements
C 618	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 881	Epoxy-Resin-Base Bonding Systems for Concrete
D 1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

## PART 2 - PRODUCTS

### 2.01 Cement

Cement shall be standard Portland cement of American manufacture, conforming to ASTM C-150, Type I. Only one brand of commercial Portland cement shall be used in the exposed concrete of the structure. Cement reclaimed by cleaning bags or from leaking containers shall not be used. Each bag shall weight approximately 94 pounds and contain one cubic foot.

### 2.02 Concrete Aggregates

- (a) Fine aggregate shall be sand having clean, hard, durable, uncoated grains and free from deleterious substances and shall conform to ASTM C-33.
- (b) Coarse aggregate shall be crushed stone having clean, hard, durable, uncoated particles conforming to ASTM C-33. Aggregate for lightweight concrete shall conform to ASTM C 330.

### 2.03 Water

Water used in mixing concrete shall be clean, potable and free from deleterious amounts of acids, alkalies or organic materials.

### 2.04 Expansion Joint Filler Material

Expansion joint material shall be asphalt-impregnated fiber strips, 1/2-inch thick, unless otherwise shown or noted on the Drawings, conforming to ASTM 1751.

## 2.05 Waterstops

Where shown on the Drawings in expansion joints and construction joints, waterstops shall be polyvinyl chloride (PVC) and shall incorporate a galvanized steel wire along both edges which shall be used to secure the waterstop in position, by tying to reinforcement, during concrete placement. The waterstop shall be of the size noted on the Drawings. The waterstop shall be equal to Wirestop CR-9380 or Burke. The waterstop shall extend the entire length of the joint and all splices shall be heat welded and tested in accordance with the manufacturer's instructions.

## 2.06 Vapor Barrier

Vapor barrier shall be polyethylene sheeting, minimum 6 mil thickness, conforming to ASTM C 171.

## 2.07 Non-Shrink Grout

Non-shrink grout shall be a ready-to-use non-metallic aggregate product requiring only the addition of water at the jobsite, and shall conform to COE CRD-C-621.

## 2.08 Admixtures

- (a) Water reducing admixture shall conform to ASTM C-494, Type A.
- (b) Water reducing, retarding admixture shall conform to ASTM C-494, Type D.
- (c) Non-Corrosive, Non-Chloride Accelerator: The admixture shall conform to ASTM C-494, Type C.
- (d) Air entraining admixture shall conform to ASTM C-260.
- (e) High range water reducer (HRWR) shall conform to ASTM C494, Type F or G.
- (f) Calcium Chloride: Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.

## 2.09 Curing and Sealing Compounds

- (a) Curing compound shall be acrylic based, conforming to ASTM C-309.
- (b) Sealing-hardener compound shall conform to ASTM C-309.

## 2.10 Bonding Compounds

Bonding Compound shall conform to ASTM 881.

## PART 3 - EXECUTION

### 3.01 Concrete Quality

- (a) All mix designs shall be proportioned in accordance with ACI 211.1. The proportioning shall be based on the requirements of a well-graded high density plastic and workable mix within the slump range and strengths required. The following class of concrete is required:

<u>Class of Concrete</u>	<u>Compressive Strength @ 28 Days</u>	<u>Slump Range</u>
A	4000	3 to 5-inch
1. Air Content: All concrete shall have an air content of 5 to 7 percent.		
2. Water-Cement Ratio: All concrete shall have a maximum water-cement ratio of 0.45.		
3. Admixture Usage: All concrete shall contain a water reducing admixture or water reducing-retarding admixture, and an air entraining agent. All concrete placed at air temperatures below 50 degrees F shall contain the specified non-corrosive non-chloride accelerator.		

### 3.02 Mix Designs

- (a) The testing laboratory shall be paid for by the Trustee.
- (b) The Contractor shall submit samples, in adequate quantities for each mix design and verification, of all concrete materials to be used on the project to the designated testing laboratory. The Contractor shall not use any concrete in this work without acceptance and verification of design mix by the testing laboratory and the approval of the Design Engineer.
- (c) If trial batches are used, the testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the Contractor. The testing laboratory shall prepare trial batches in accordance with ACI 211.1.

- (d) If field experience method is selected, the proposed mix design must be accompanied by complete standard deviation analysis and at least 30 consecutive strength test that represent the proposed mix.
- (e) The proposed mix design and supporting data must be submitted, in triplicate, to the testing laboratory for their review and comments at least 21 days prior to the expected start of concreting operations. The testing laboratory will forward two copies of the submittal to the Trust Representative with their comments. The Trust Representative will review the submittal and return one copy to the Contractor with the Trust Representative's comments.
- (f) Compression test specimens made to verify the mixes shall be made in accordance with ASTM C-192. Aggregates shall be tested in accordance with ASTM C-33. All compression test specimens shall be tested in accordance with ASTM C-39.

### 3.03 Plant Mixing

#### (a) Proportioning Concrete

1. Proportions shall be in compliance with approved design mix for each class of concrete.
2. The mixing plant shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete.
3. Concrete materials shall be measured by weight except that admixtures shall be measured by volume.

#### (b) Batching

1. The Contractor shall provide all necessary equipment to accurately determine and control actual amount of materials entering into the concrete mix. Individual ingredients shall be weighted separately for each batch. Accumulative weighing will be allowed if equipment is in acceptable working order as determined by the testing laboratory and approved by the Trust Representative. Accuracy of all weighing devices shall be

such that successive quantities can be measured to within one percent of the desired amount.

2. Completely discharge contents of the mixer before each new batch is loaded. Use of retempered concrete is not permitted.
3. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C-94 and to the following:
  - a. A separate water metering device (not truck tank) shall be used for measuring water added to the original batch.
  - b. Use of wash water as a portion of the mixing water is not permitted. Wash water added to empty drums after discharging shall be dumped before a new batch is received.
  - c. Centrally mixed concrete shall be mixed for the length of time specified herein, not "shrink-mixed".
  - d. Mixing drums shall be watertight.
  - e. Concrete shall be discharged within one hour from the time concrete was mixed, if centrally mixed, or from time the original water was added, if transit-mixed.
  - f. Furnish delivery ticket with each load of concrete delivered under these Specifications. Delivery ticket shall show clearly the class and strength of concrete, size of coarse aggregate, water per cubic yard, the slump ordered, quantities of all admixtures, and the date and time of departure from the batching plant.

### 3.04 Conveying Equipment

- (a) If concrete is to be transported in carts or buggies, the carts or buggies shall be equipped with pneumatic tires.
- (b) Equipment for chuting or other methods of conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at delivery without segregation of materials.

### 3.05 Conveying

- (a) Concrete shall be conveyed from mixer to place of final deposit by methods which will prevent separation or loss of the material.
- (b) Runway supports shall not bear upon reinforcing steel or fresh concrete.
- (c) All conveying equipment shall be thoroughly cleaned before each run of concrete is begun.

### 3.06 Delivery and Protection of Materials

Deliver ready-mixed concrete in compliance with requirements set forth in ASTM C-94.

### 3.07 Severe-Weather Provisions

- (a) Hot-Weather Concreting
  - 1. Provide adequate methods of lowering temperature of concrete ingredients so that the temperature of concrete when placed does not exceed 90 degrees F.
  - 2. When the weather is such as to raise concrete temperature, as placed, consistently above 90 degrees F, Pozzoloth retarder shall be used.
  - 3. Subgrade and forms shall be wetted with water before placing of concrete. All excess water shall be removed before concrete is placed.
  - 4. Curing shall start as soon as practicable to prevent evaporation of water. Flat work shall be protected from dry winds, direct sun and high temperatures.



(b) Cold-Weather Concreting

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. No frozen materials, or materials containing ice, shall be used.
2. All concrete materials and all reinforcement, forms, fillers and ground with which concrete is to come into contact shall be free from frost.
3. Whenever the temperature of the surrounding air is below 40 degrees F and falling, all concrete placed in the forms shall have a temperature of between 70 and 80 degrees F, and adequate means shall be provided for maintaining a temperature of not less than 70 degrees F for three days, or 50 degrees F for five days, or for as much more time as is necessary to insure proper curing of the concrete. If high early strength concrete is used, the requirement for maintenance of 50 degrees F can be reduced to three days.
4. Use only the specified non-chloride accelerator. Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.
5. Housing, covering or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heat is discontinued.

3.08 Construction Joints and Expansion Joints

- (a) Construction Joints: Early in the construction program, the Contractor shall review with the Design Engineer any construction joints proposed for use which are not indicated on the Drawings. The Contractor shall not use any construction joints which are not approved by the Design Engineer. In all cases, construction joints shall occur at sections of minimum shear. Where construction joint is to be made, surface of the concrete shall be roughened (construction joints detailed with key ways in slabs and walls, are not required to be roughened) and thoroughly cleaned of foreign matter and laitance. In addition to the foregoing, joints shall be dampened with water and the specified bonding compound applied, or a slush coat of neat cement grout shall be applied.

Additional construction joints that are requested by the Contractor and approved by the Trust Representative shall be of the type shown and/or noted on the Drawings for the specific element(s) being considered (i.e., wall slabs, etc.).

- (b) Expansion joints shall be installed as indicated.

### 3.09 Waterstops

Waterstops shall be installed as indicated and noted on Drawings and shall be made continuous by fusion welds.

### 3.10 Inspection of Work Before Placing

- (a) The Contractor shall inspect the forms to receive concrete for any deficiencies which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.
- (b) Give the Trust Representative at least 48 hours notice before any concrete is to be cast. Concrete shall not be cast until the Trust Representative has observed and given approval of the work to be cast including, but not limited to, the placement of all the reinforcing, accessories, forms and the surfaces to be cast against. Such observations are in the nature of assisting the Contractor to minimize errors and in no case will they serve to relieve the Contractor of the responsibility to provide the materials and workmanship required by the Contract Documents.
- (c) Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable Sections of the Specifications for that work.
- (d) The Contractor shall not place in the concrete any item that is not authorized to be placed by the Drawings and Specifications. The Contractor shall insert all the items as required by the other trades and properly position and secure them in their intended location. Openings other than those which are facilitated by sleeves shall be properly formed and positioned as required by the other trades.
- (e) Do not place concrete in forms until all foreign matter has been removed from forms and the reinforcing steel is in proper condition for placement of concrete.

- (f) Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.

### 3.11 Placing

- (a) Deposit concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not deposit concrete on work that has partially hardened or been contaminated by foreign material, and do not use retempered concrete. In no case shall Group II concrete be cast when the elapsed time after addition of water and cement to batch exceeds one hour. For Group I concretes, this elapsed time may be extended if sufficient data from this construction indicates a time extension is permissible and if approved by the Design Engineer.
- (b) Concrete shall be placed to avoid the displacement of reinforcing, and coating or spattering the reinforcing steel. The placing of concrete within form work shall be regulated so that the pressure within form work does not exceed the design pressure. In placing concrete each layer shall be placed following the preceding layer to prevent lines of separation or "cold joints" in the work. After the concrete reaches its initial set, jarring the formwork or placing strain or vibration on the ends of projecting reinforcing bars shall be carefully avoided.
- (c) Concrete shall not be dropped more than four feet. For greater distances of drop, concrete shall be handled with metal chutes or tremie pipes. Greater drops shall be permitted only if approved by the Design Engineer.
- (d) Once concreting is started, it shall be carried on as a continuous operation until placing of the concrete between construction joints is completed. The top surface will be finished to the required alignment.
- (e) Concrete shall be placed in layers not over 12-inches deep and each layer shall be compacted with the aid of mechanical internal-vibrating equipment supplemented by hand spading. Vibrators shall in no case be used to transport concrete. Use of form vibrators will not be permitted. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the concrete. At least one spare vibrator shall be

maintained as a relief. Duration of vibrator use shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrator shall not be lowered into courses that have begun to set. Apply vibrator at uniformly spaced points not further apart than the visible effectiveness of the machine.

- (f) Install vapor barrier over prepared sub-base for all concrete floor slabs on grade. Use largest sheets practicable to reduce number of joints. Lap joints a minimum of 24-inches. Remove torn and punctured sheets and replace with new sheets prior to placing concrete. Placing of concrete shall be done in a manner that will not damage the vapor barrier material. The sub-base material shall be as shown and/or noted on the Drawings.
- (g) Type and use of vibrators shall be in accordance with ACI 301.

### 3.12 Protection

Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of the floor shall be permitted for the first seven days after placing of concrete.

### 3.13 Curing

- (a) All Slabs. After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days.
  - 1. Concrete shall be kept moist by any one, or combination, of the following methods:
    - a. Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.
    - b. Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
    - c. Pervious Sheeting: Completely cover surface and edges of the concrete with

two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheetting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

- d. Impervious Sheetting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheetting throughout the curing period. Lay sheetting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheetting not less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheetting or provide new sheetting. Inspect surface of concrete daily for wetness. The surface shall be kept continuously wet during the curing period.

- (b) All Other Concrete: After placement, concrete shall be maintained in a moist condition for the same periods as specified above.

- 1. Concrete in Formed Surfaces - Slabs, Beams, Columns and Building Walls: Keep forms and exposed surfaces wet with water during the curing period. If forms are removed before the end of the curing period, apply a curing compound within one hour after form removal.

### 3.14 Patching

- (a) Any concrete which is not formed as shown on the Drawings, or for any reason is out of alignment or level or shows a defective surface, or shows defects which reduce the structural adequacy of a member or members, as determined by the Trust Representative, shall be considered as not conforming with these Specifications and shall be removed from the Project by the Contractor at Contractor's own expense, unless the Design Engineer grants permission to patch the defective area, which shall be done in accordance with the following procedure:

1. Permission to patch any such area shall not be considered a waiver of the Design Engineer right to require complete removal of the defective work if the patching does not, in the Trust Representative's opinion, satisfactorily restore the quality and appearance of the surface or the structural adequacy of the member or members.
- (b) After removing the forms, all concrete surfaces shall be inspected and any joints, voids, stone pockets or defective areas permitted by the Trust Representative to be patched and all tie holes, shall be patched. Defective areas shall be chipped away to a depth not less than 1-inch with the edges perpendicular to the surface. Remove defective areas to sound concrete with clean, square cuts. Dampen concrete surfaces to be in contact with patching concrete and apply the specified bonding compound. Place patching concrete over the bonding compound as specified by the manufacturer. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete. Before patching mix is applied, the prepared surface shall first be approved by the Design Engineer.
- (c) Patching concrete mix (or mortar) shall be subject to the approval of the Design Engineer. The patching concrete shall be compacted into place and screeded off so as to leave the patch higher than the surrounding surface. It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finished. The patch shall be finished to match the adjoining surface. All patches shall be cured as specified for the original concrete.
- (d) Tie holes left by withdrawal of rods or the holes left by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth.

### 3.15 Finishes on Formed Surfaces

(a) Upon completion of patching, surfaces of concrete shall be finished as follows:

1. Rubbed stone finish, where noted on the Drawings
  - a. Stone rubbed finish shall be produced by casting concrete against plywood forms and by rubbing the surfaces with carborundum stone and water, after patching of tie holes and depressions, to a true, even and smooth finish of uniform color and texture. No slush coat of cement grout or cement wash will be permitted at any state of the finishing.
  - b. Areas to be rubbed shall be finished as soon as forms can be stripped. Strip only those forms on areas which can be finished in the same day as the forms are stripped.
2. Common finish shall be produced by filling all tie holes, honeycomb and depressions, and knocking off and evening up burrs and form marks.
  - a. All concrete surfaces not receiving a stone rubbed or rough finish shall receive a common finish.
3. Rough finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed.
  - a. All concrete surfaces which will be covered by earth and which will not be visible in the completed structure, shall receive a rough finish.

### 3.16 Steel Troweled Finish - Floor Slabs

- (a) Steel troweled finish shall be applied to the surface of all concrete floor slabs and interior equipment pads and slabs shown on the Drawings or specified to receive a steel troweled finish.
- (b) Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the

surface shall be wood floated, by hand or power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed 1/4-inch under a 10 foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the Drawings.

- (c) After the concrete has received a float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture before floating or troweling shall not be hastened by the dusting on of dry sand or cement. Both power and hand troweling shall be required. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be in true plane within the tolerance specified. Any deviation from this condition which remains after the troweling is completed shall be corrected by grinding.

### 3.17 Broom Finish

- (a) Broom finish shall be applied to all exterior side walks, walkways, platforms and all steps and landings both interior or exterior.
- (b) The surface shall be given a floated finish as specified above, then finished with a flexible bristle broom or burlap belt drawn across the surface. Surface must be hardened sufficiently to retain the scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

### 3.18 Testing Laboratory

- (a) The testing laboratory shall be paid by the Trustee. The laboratory shall have access to all places where concrete materials and concretes are manufactured, stored, proportioned, mixed, placed and tested. Duties shall include, but not necessarily be limited to the following:



1. Make, store, transport, cure and test compression specimens made during placing of concrete. Compression test specimens shall be tested in accordance with ASTM C-39. Test reports shall show all pertinent data, such as class of concrete, exact location of pour, air temperature, date of pour, time of pour, truck number for ready-mixed concrete, date on which specimen was broken, age of specimen, compressive strength of specimen, slump test results, and air content of pour from which the specimen was made. One copy each of all tests shall be sent to the Contractor and two copies each to the Trust Representative.
2. For each class of concrete, take four standard test cylinders from each 100 cubic yards or fraction thereof of concrete placed, not less than four cylinders for each 5,000 square feet of surface area placed in any single day. Two of these cylinders shall be designated for the 28 day test and shall comprise a test under the definition of these Specifications. One cylinder will be broken at seven days and will be used as an aid in determining the early strength of the concrete and the 28 day strength, and one cylinder retained in reserve for later testing if required.
3. Periodically inspect the batching plant and file a report with the Trust Representative stating whether the supplier's equipment and methods meet the requirements of these Specifications.

- (b) Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

### 3.19 Evaluation of Compression Tests

- (a) Evaluation of compression test results shall be as follows:
1. For each class of concrete, compression-strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three

consecutive compression-strength tests equal or exceed the 28 day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi. Strength tests of specimens cured under field conditions may be required by the Trust Representative to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field quality-control laboratory at the same time and from the same samples as the laboratory-cured specimens.

- (b) Faulty Concrete: Failure to meet any of the specified conditions constitutes faulty concrete. Unless otherwise directed by the Design Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Trustee.
- (c) Additional Testing: If permitted by the Trust Representative, additional testing shall be subject to the approval of the Trust Representative and the Design Engineer and at no expense to the Trustee. Load test, if permitted by the Trust Representative and the Design Engineer shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Trust Representative.
- (d) Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the Contractor of the obligation to furnish concrete of the class and strength specified.

### 3.20 Non-Shrink Grout

All column base plates, equipment bases and other locations noted on the structural Drawings shall be grouted with the specified non-shrink, non-metallic grout.

END OF SECTION

## SECTION 15051

### BASIC MECHANICAL MATERIALS AND METHODS

#### PART 1 - GENERAL

##### 1.01 Scope

- (a) The work described in this Section and/or indicated on the Drawings shall include, except where otherwise noted, the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all mechanical systems. All mechanical work shall be accomplished by workers skilled in the various trades involved.
- (b) Prior to the ordering or purchase of any equipment or materials or the layout or installation of any work, the Contractor shall visit and examine the site and shall examine and understand the work shown on the Drawings and described in these Specifications. If any work involves existing equipment, ductwork, piping, buildings, etc., the Contractor shall first verify model numbers, electrical characteristics, sizes, dimensions, etc. to be compatible with the work shown on the Drawings.
- (c) Throughout the course of the Project, the Contractor shall schedule and coordinate work with the Trust Representative and other trades to optimize space utilization and avoid conflict or interference with the work of other trades, structural elements, doors, windows, lights, conduit and other equipment or systems.

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(d) Unless otherwise shown on the Electrical Drawings, the mechanical work shall include:

1. The furnishing and installation of all motors, motor starters, relays and other controls and control wiring necessary for the proper operation of all mechanical equipment. Single point power wiring to mechanical equipment shall be provided as a part of the electrical work.
2. All controls and control wiring shall be provided under this Division. A transformer shall be furnished and installed to convert power voltage to control voltage as required. The transformer may be an integral part of the starter.
3. Magnetic starters complete with "hand-off-automatic" switches, with running indication lights in an approved enclosure, shall be furnished and installed for mechanical equipment automatically started and stopped, or otherwise controlled. Starters for all manually controlled equipment shall include start-stop pushbuttons with running indication lights in an approved enclosure.
4. Starters shall be of the reduced voltage part winding type for all equipment with motors 50 HP and larger.
5. Disconnect switches shall be provided for mechanical equipment in accordance with National Electrical Code. Coordinate type (fused or not), fuse ratings, enclosure type and installation with equipment nameplate, NEC, NEMA and Division 16 requirements.

(e) Unless otherwise noted, enclosures shall be the same NEMA type as shown on the Electrical Drawings.

(f) The Contractor will be held responsible for the satisfactory and complete execution of all work included. The Contractor shall produce complete finished operating systems and provide all incidental items required as part of the work, regardless of whether such item is particularly specified or indicated.

## 1.02 Qualifications

All materials shall be furnished by manufacturers fully experienced, reputable and qualified in the manufacture of the particular material to be furnished. All material shall be designed, constructed and installed in accordance with standard practices and methods and shall comply with these Specifications as applicable.

## 1.03 Submittals

(a) Submittals for all mechanical work shall conform to the requirements of the section entitled "Shop Drawings, Product Data and Samples" of these Specifications.

(b) Drawings and Specifications

1. The Drawings are diagrammatic and, unless specifically dimensioned, are intended to show only the general arrangement of equipment and accessories, and the general routing of piping, etc. The Drawings do not specifically show every fitting, offset, contour, etc. required to accomplish the intended work or to avoid every interference that may be encountered. It shall be the responsibility of the Contractor to arrange all work to fit within the allowed space without modifying any building structure or property, and to make readily accessible all equipment and accessories requiring servicing or maintenance.
2. Should any changes be deemed necessary by the Contractor in items shown on the Contract Drawings, shop drawings, descriptions and the reason for the proposed changes shall be submitted to the Trust Representative for approval.
3. Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Trust Representative's attention before Bids are submitted.
4. Titles of sections and paragraphs in these Specifications are introduced merely for convenience and are not to be construed as complete segregation of tabulation of the various units of material and/or work.

- (c) Operating and Maintenance Instructions: Complete, neatly framed instructions for the care and operation of all equipment shall be provided and installed where directed. In addition, operation and maintenance instructions shall be provided in accordance with the requirements of the section entitled "Operating and Maintenance Data" of these Specifications. The Contractor shall instruct the Trustee's personnel during the adjustment and testing period. The Contractor shall also, in the presence of both the Trust Representative and the Engineer demonstrate the complete operation of each and every piece of apparatus. Instructional periods shall be for such lengths of time as may be necessary to thoroughly familiarize operating personnel with the proper care, operation and maintenance of the equipment.
- (d) Permits and Inspections
  - 1. The Contractor shall obtain and pay for, as part of the mechanical work, all permits, fees, licenses, taxes, assessments, etc. necessary for performing the work outlined in the Contract Documents.
  - 2. All applicable certificates of inspection shall be delivered to the Trustee at the completion of the work.

#### 1.04 Transportation and Delivery

- (a) As part of the mechanical work, the Contractor shall provide and pay for all transportation, delivery and storage required for all equipment and materials.
- (b) The mechanical contractor shall closely coordinate the ordering and delivery of all mechanical equipment with other trades to assure that equipment will be delivered in time to be installed in the building without requiring special or temporary access or building modifications. Certain equipment may have to be installed prior to the erection of the building walls or roofs.

#### 1.05 Storage and Protection

- (a) Upon receipt of all equipment and materials, they shall be properly stored to protect them from vandalism, theft, the elements and other harm or damage. Any equipment or materials received in a damaged condition, or damaged after receipt, shall not be installed. Only new undamaged equipment in first-class operating condition shall be installed.
- (b) Provide protection covers, skids, plugs or caps to protect equipment and materials stored or otherwise exposed during construction.

#### 1.06 Quality Assurance

- (a) The manufacturer shall provide written certification to the Trust Representative that all equipment furnished complies with all applicable requirements of these Specifications.
- (b) Codes and Standards

1. All mechanical work shall be performed in accordance with all applicable codes, ordinances, rules and regulations of local, state, federal or other authorities having jurisdiction. As a minimum, this shall include:

- a. BOCA National Fire Prevention Code, 1990
- b. BOCA National Mechanical Code, 1990
- c. Massachusetts State Plumbing and Gas Code, 1990
- d. National Fire Protection Association Codes.
- e. Unless otherwise specified on the Drawings, the latest edition of all codes, ordinances, etc. shall be followed. Where code or other requirements exceed the provisions shown on the Contract Documents, the Contractor shall notify the Trust Representative. Where provisions of the Contract Documents exceed code or other requirements, the Work shall be performed in accordance with the Contract Documents.

2. All equipment, products and materials used in mechanical work shall be Underwriter's Laboratories listed or labeled as applicable.
  3. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Design Engineer and the Trust Representative.
- (c) Allowable Tolerances: Equipment shall be readily adaptable for installation and operation in the structures shown on the Drawings. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the Trustee. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

#### 1.06 Warranty

- (a) All mechanical work described in the Contract Documents shall be warranted from the date of final acceptance in accordance with the section entitled "Warranties and Bonds" of these Specifications.
- (b) This warranty shall apply to all equipment, materials and workmanship.
- (c) During the warranty period, all defects in mechanical systems shall be corrected in an acceptable manner, consistent with the quality of materials and workmanship of original construction, at no expense to the Trustee.

### PART 2 - PRODUCTS

#### 2.01 Materials and Construction

- (a) General
  1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be new, of the best grade and quality and of current production, unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Trust Representative.



2. All equipment, products and materials used in mechanical work shall be Underwriter's Laboratories listed or labeled as applicable.
  3. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage or wear.
  4. Electric motors shall be standard efficiency, drip-proof type unless otherwise specified.
- (b) Piping: See appropriate sections of Division 15 for Specifications on various piping systems. See Part 3 of this Section for general stipulations on installation of piping systems.
- (c) Valves: See appropriate sections of Division 15 for Specifications and Part 3 of this Section for general stipulations on valve installation.
- (d) Unions
1. Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.
    - a. Steel Pipe: Unions 2-1/2-inches and smaller shall have ground joints. Unions 3-inches and larger shall have flanged unions.
- (e) Equipment Bases: Each piece of equipment which is motor driven shall be furnished with an approved base, which shall be in addition to the foundation. Each base shall be furnished integral with the equipment or apparatus, or shall be furnished as a separate item, designed to accommodate the equipment or apparatus. Submit shop drawings for all foundations and supports for review.
- (f) Dielectric Isolation
1. Wherever copper, brass or bronze piping systems are connected to steel or iron piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be

isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure of the system involved.

2. Dielectric isolators shall be Watts, Epco, Crane or Maloney.

### PART 3 - EXECUTION

#### 3.01 Installation

##### (a) General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be installed according to the manufacturer's recommendations and in accordance with the best practice and standards for the work.
2. All work shall be performed by competent personnel satisfactory to the Trustee and Trust Representative. All work requiring particular skill shall be performed by persons that have had special training and past experience in that line of work.

##### (b) Equipment Support

1. Major equipment supports (concrete foundations, etc.) shall be furnished and installed under other Divisions of the Contract Documents as shown on the Drawings. The mechanical work shall include, however, the furnishing and installation of all miscellaneous equipment supports, housekeeping pads, structural members, rods and clamps required to provide adequate support of all mechanical equipment.
2. Unless otherwise shown on the Drawings, all mechanical equipment, piping and accessories shall be installed level, square and plumb.

(c) Pipe Penetrations

1. Sleeves shall be installed in concrete slabs for pipe penetrations. Sleeves shall be standard weight steel pipe. Sleeves shall be sized to provide a minimum of 1/4-inch clearance between the sleeve and pipe. For insulated pipes the clearance shall be between the sleeve and the insulation.
2. As far as possible, all pipe penetrations shall be provided for at the time of concrete construction. Where drilling is required, only core drills shall be used. Star drills shall not be used.

(d) Welding

1. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.
2. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping. The Contractor shall pay for all electrical energy and/or gas used in welding.

(e) Equipment Connections

1. Extend water and gas air lines to the various items of equipment as indicated or required, terminating the lines where and as directed. Make all final connections. Provide shut-off valves and unions at each water and gas connection to each item of equipment requiring same.
2. During the roughing-in phase of the work, extend service lines to the various items of equipment, terminating them at the proper points for connection to those items of equipment as indicated on the detailed drawings of the equipment and/or as directed. During the time the equipment is being installed or after it is in place, make all final connections thereto.

- (f) Cutting and Patching: Where cutting or patching becomes necessary to permit the installation of any work or should it become necessary to repair any defects that may appear in patching, the Contractor shall make the necessary repair at no cost to the Trustee.
- (g) Large Apparatus and Equipment: All large apparatus and equipment which is specified or shown to be furnished or installed under this Contract, and which may be too large to be moved into its final position through the normal building openings planned, shall be placed by the Contractor in its approximate final position before any obstructing structure is installed. All apparatus shall be cribbed up from the floor and cared for as specified under "Storage and Protection" or as directed by the Trust Representative.
- (h) Cross Connection and Interconnections: The Contractor shall verify location of all existing utilities and make all connections to existing facilities as required.
- (i) Thermal Expansion of Piping
  - 1. The Contractor shall furnish and install all devices required to permit the expansion and contraction of all work installed by the Contractor. Swing joints, turns, expansion loops or long offsets shall be provided wherever shown on the Drawings or wherever necessary to allow for the expansion of piping. Broken pipes or fittings broken due to rigid connections must be removed and replaced at the Contractor's expense.
  - 2. Anchor all lines having expansion joints so that expansion and contraction effect is equally distributed. Verify exact locations of anchors with the Trust Representative prior to making installation. The lines having expansion joints shall be accurately guided on both sides of each joint. These guides shall consist of saddles and "U" clamps properly arranged and supported. Submit complete details for approval.
  - 3. In installing expansion members, exercise care to preserve proper pitch on lines. Furnish and install all special fittings, connectors, etc., as required.

### 3.02 Surface Preparation, Shop and Field Painting

Touch-up painting of mechanical equipment shall be part of the mechanical work. All equipment and materials that are painted or coated by the manufacturer shall be touched-up prior to completion to conceal any and all scratches or other finish irregularities and to maintain the integrity of the paint or coating. All painting and coating shall match the original and shall conform to the requirements detailed in other sections of these specifications.

### 3.03 Inspection and Testing

- (a) Testing of Pipelines: Refer to the section entitled "Testing of Piping and Hydraulic Structures" of these Specifications for general requirements.
- (b) The mechanical work shall include all materials and labor required to properly test and balance all mechanical systems as required by codes and as described herein.
- (c) Concealed, underground and insulated piping shall be tested in place before concealing, burying or covering. Tests shall be conducted in the presence of the Trust Representative or designated representative. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Trustee and the Trust Representative.
- (d) Unless otherwise specified herein, all mechanical piping shall be tested as required by Code to 1-1/2 times the rated system pressure or 150 psig, whichever is greater. Care shall be taken to isolate all equipment not suitable for this test pressure by installing pipe caps or blank flanges at the equipment connections. All valves and fittings shall be tested under pressure.

### 3.04 Cleaning

- (a) At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the site.
- (b) After all equipment has been installed, but prior to testing and balancing, all equipment, piping, etc. shall be thoroughly cleaned both inside and out.
- (c) Prior to Trustee review and acceptance, all systems shall be finally cleaned and shall be left ready for use.

END OF SECTION

## SECTION 15094

### PIPE SUPPORTS AND HANGERS

#### PART 1 - GENERAL

##### 1.01 Requirements Included

- (a) Work specified in this Section shall comply with the provisions of Division 1 and Section 15051.
- (b) The work of this Section includes all pipe supports and brackets necessary to install piping furnished under these Contract Documents. The Contractor shall furnish and install all foundations, anchor bolts, pipe supports, shims, clamps, hardware and supplemental steel required for a complete installation as shown on the Drawings and/or specified herein.
- (c) The Drawings do not show every pipe hanger location, but are intended to provide a guide as to type and usage of pipe supports intended under this Contract. The Contractor shall provide all pipe supports required to securely support all piping in accordance with the referenced standards.

##### 1.02 Project Conditions

- (a) Building structures shall be erected under other sections of these Specifications and should be essentially complete prior to starting work under this Section.
- (B) The Contractor shall be responsible for field verifying existing dimensions prior to fabrication of pipe support systems.

##### 1.03 Sequencing and Scheduling

The Contractor shall coordinate scheduling of pipe support installation with the piping system installation to prevent any damage to installed piping due to lack of pipe supports.

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#### 1.04 References

- (a) Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Standards

SP-58                Pipe Hangers and Supports -  
Materials, Design and Manufacture  
(1983)

SP-69                Pipe Hangers and Supports -  
Selection and Application (1983)

SP-89                Pipe Hangers and Supports -  
Fabrication and Installation  
Practices (1985)

- (b) American National Standards Institute (ANSI)  
Standards:

B31.1                Code for Pressure Piping - Power  
Piping

- (c) American Society of Mechanical Engineers (ASME)  
Standards:

Section VIII        Pressure Vessels

Section IX          Welding and Brazing Qualifications

- (d) American Society for Testing and Materials (ASTM)  
Standards:

A136-84             Structural Steel

A153-82             Zinc Coating (Hot Dip) on Iron and  
Steel Hardware

A730-80             Repair of Damaged Hot-Dip  
Galvanized Coatings

#### 1.05 Submittals

Complete shop drawings and engineering data shall be submitted to the Trust Representative in accordance with the requirements of the section entitled "Shop Drawings, Product Data and Samples" of these Specifications.



#### 1.06 Storage and Protection

Pipe supports and accessories shall be stored and protected in accordance with the requirements of the section entitled "General Equipment Stipulations" of these Specifications.

#### 1.07 Quality Assurance

- (a) Work shall be installed by workmen experienced in the design, selection, fabrication and installation of pipe support systems.
- (b) Selection, fabrication and installation of pipe hangers and supports shall conform to the requirements of ANSI B31.1, MSS SP-58, SP-69 and SP-89.
- (c) Pipe support systems shall utilize standard manufactured supports wherever possible.
- (d) Pipe support materials in contact with piping shall be compatible with the piping materials such that neither shall have a deteriorating action on the other.
- (e) Supplemental steel shall be designed per AISC Steel Construction Manual or Standard Building Code.

### PART 2 - PRODUCTS

#### 2.01 Acceptable Manufacturers

Acceptable manufacturers of pipe support products are ITT Grinnell, B-Line Systems, Fee and Mason or Michigan Hanger Company.

#### 2.02 Materials and Construction

- (a) All supports and hangers shall meet the following material requirements:
  - 1. All structural steel shall conform to ASTM A 36.
  - 2. All pipe support columns shall conform to ASTM A 53, Grade B and shall be minimum Schedule 40.
  - 3. All embedded anchor bolt materials shall conform to ASTM A 193, Grade B8; ASTM A 276, Type 304; or IFI-104, Grade 304. Nuts shall be heavy hex nuts conforming to ASTM A 194,

Grade 8 or IFI-104, Grade 304. Minimum anchor bolt size for pipe supports shall be 5/8-inch diameter.

4. All carbon steel or malleable iron straps, hangers, clamps, U-bolts and other hardware in contact with the pipe shall be shop primed except where specified or shown on the Drawings to be galvanized.
5. Expansion type anchor bolts shall be of stainless steel construction and shall comply with Federal Specifications FF-S-325.
6. Pipe supported from underneath and subject to expansion shall have adjustable pipe roll stand supports equal to Grinnell, Figure 274 or Fee and Mason, Figure 161. The pipe roll stand shall be supported by concrete piers, structural steel or steel brackets as required.
7. Pipe supported from underneath and not subject to expansion shall have cast-in-place concrete supports as shown on the Drawings or adjustable pipe saddle supports on properly sized pipe stanchions and ample, properly grouted floor flanges. Saddle supports shall be equal to Grinnell, Figure 264 or Fee and Mason, Figure 291.
8. All concrete piers shall be Class "A" concrete meeting the requirements of these Specifications.
9. Riser clamps for vertical piping shall be steel riser clamps equal to Grinnell Fig. 261.
10. U-Bolts: Steel with four finished hex nuts, galvanized, special dimensions as required for installation, Grinnell Figure 137 (137S for special dimensions) or equal.
11. Turnbuckle: Galvanized forged steel construction, Grinnell Figure 230 or equal.

## PART 3 - EXECUTION

### 3.01 Installation

#### (a) General

1. Pipe supports shall be installed in complete conformance with the manufacturer's recommendations and the Contract Documents.
2. Pipe supports shall be selected based on pipe size. Provide all angles, channels and other structural supports to support the piping systems.
3. All supporting equipment shall be designed with a minimum safety factor of 5 based on the ultimate tensile strength of the material.
4. Contact between ferrous supports and non-ferrous piping materials shall not be permitted. Supports and clamps shall be rubber coated or copper-plated as necessary to prevent this condition.
5. Adequate supports shall be provided so that there is no movement or visible sagging between supports.
6. Carbon steel shall be supported on maximum intervals as follows:

<u>Pipe Size, Inches</u>	<u>Maximum Interval for Steel, Feet</u>	
	<u>Liquid</u>	<u>Gas</u>
1/2	5	6
3/4	6	7
1	7	9
1-1/2	9	11
2	10	13
2-1/2	11	14
3	12	15
4	13	17
6	17	21
8	19	24
10	22	27
12	23	29
14	25	32
16	27	35

<u>Pipe Size, Inches</u>	<u>Maximum Interval for Steel, Feet</u>	
	<u>Liquid</u>	<u>Gas</u>
18	28	37
20	30	39
24	32	42

7. FRP piping shall be supported on maximum intervals as follows:

<u>Tubing Size, Inches</u>	<u>Maximum Interval, Feet</u>
3/8 and smaller	2
1/2 - 5/8	3
3/4 - 1-1/8	4
1-1/4 - 2	5
2-1/2 - 3-1/2	6
4	7
6	8

8. Where indicated or directed by the Trust Representative, exposed piping and tubing carrying liquid shall be sloped as necessary to permit complete draining. Pipe deflection between supports shall be considered when determining the slope required to permit complete drainage. All underground piping shall be sloped uniformly for complete drainage.
9. Open ends of pipe columns used for support shall be completely covered with 1/4-inch thick plate or angle leg welded in place.
10. Vertical piping shall be supported as shown or required to prevent buckling or swaying utilizing special brackets.
11. Provide a support within 18-inches of each elbow and within 24-inches of each equipment connection.
12. On insulation finished with an aluminum jacket, a 1/32-inch thick sheet of neoprene shall be provided between the jacket and the shield.
13. Hangers shall be selected to fit around insulation.

14. Following installation all pipe supports shall be field primed and painted with the specified painting system for the application in accordance with the requirements of the section entitled "Painting" of these Specifications.
15. Unless otherwise shown, piping shall not be fastened to a support in such a manner that would prevent axial movement due to thermal expansion and contraction.
16. Unless otherwise noted, piping dimensions shown on the Drawings are for reference only and shall be verified in the field by the Contractor. The Contractor shall size supports and hangers using actual field dimensions.

(b) Installation - Horizontal Piping

1. Provide all necessary steel angles and other items required to maintain the minimum support spacing.
2. Pipe supports for horizontal piping supported on concrete floors and on concrete bases shall be adjustable pipe saddle support with U-bolt and screwed floor flange. Bolt floor flange to floor and bases utilizing all bolt holes, use foam glass inserts at all saddles, sleeves, etc.

(c) Installation - Pipe Supports for Vertical Piping: Supports for all pipes shall fit directly around the pipe, except that on insulated pipes, the support shall be insulated and provided with vapor barrier.

(d) Supplemental Steel

1. All supplemental steel shall be fabricated in accordance with the requirements of the AISC Manual of Steel Construction and the Standard Building Code.
2. No flame cutting of galvanized steel members will be permitted.
3. All galvanized surfaces damaged or exposed by cutting or drilling shall be resurfaced in accordance with ASTM A780.

### 3.02 Surface Preparation and Shop Painting

Fabricated pipe supports and accessories, except where shown on the Drawings to be galvanized, shall be cleaned and shop primed.

### 3.03 Painting

- (a) Coat all non-glavanized steel with a two-part epoxy exterior coating system equivalent to that manufactured by Rust-o-leum, PPG, or Sherman-Williams
- (b) Apply base primer coat compatible with the finish coat in accordance with the manufacturer's instructions.
- (c) Clean all rust, machine oils, and other surface imperfections in strict accordance with the coating system manufacturer's recommendations.
- (d) Apply final finish coat in accordance with the manufacturer's instructions, with special attention to proper temperature and humidity conditions. Monitor finish coat material usage to insure proper finish coat thickness.
- (e) Repair all abrasions in the coat after installation in accordance with the coating system manufacturer's instructions.

### 3.04 Cleaning

Prior to acceptance of the work of this Section, thoroughly clean all installed materials, equipment and related areas in accordance with the section entitled "Cleaning" of these Specifications.

END OF SECTION

## SECTION 15100

### VALVES

#### PART 1 - GENERAL

##### 1.01 Scope

- (a) The equipment shall include, but is not necessarily limited to, the following:

1. Utility Service Valves

##### 1.02 References

- (a) Massachusetts State Plumbing and Gas Code, 1990
- (b) National Fuel Gas Code, 1990
- (c) National Fire Protection Association (NFPA) Standards
- (d) Federal Specifications (FS)
  1. MSS SP-80 Valve, Angle, Check, and Globe, Bronze (125, 150, and 200 pound), Threaded Ends, Flange Ends, Solder End, and Brazed Ends for Land Use
  2. WW-V-58 Valve, Gate, Cast iron; Threaded and Flanged for Land Use

##### 1.03 Service

Valves specified in this Section are intended for non potable water and natural gas service.

##### 1.04 Submittals

- (a) Submit to the Trust Representative within 30 days after execution of the Contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

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- (b) Complete shop drawings of all valves and appurtenances shall be submitted to the Trust Representative for approval in accordance with the section entitled "Shop Drawings, Product Data and Samples" of these Specifications. Clearly indicate make, model, location, type, size and pressure rating. Drawings submitted not showing installed location for use shall be returned without review.

## PART 2 - PRODUCTS

### 2.01 Acceptable Manufacturers

- (a) Provide valves of same manufacturer throughout where possible.
- (b) Provide valves with manufacturer's name and model (figure number), valve size, and pressure rating clearly marked on outside of body.

### 2.02 Valve Connections

- (a) Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.
- (b) Thread pipe sizes 2-1/2-inches and smaller.

### 2.03 Utility Service Valves

- (a) This service includes non-potable water and natural gas.
- (b) Non Potable Water Valves
  - 1. Ball Valves
    - a. Valves shall be bronze body with bronze lever handle, full port, bronze ball and stem, TFE seats and packing, and screwed connections. Valves shall be rated for 300 psi maximum operating pressure and 180 degrees F maximum temperature.
    - b. Ball valves shall be Consolidated Brass, Dyna-Quip, Jamesbury, Nibco or Worchester.



(c) Natural Gas Valves

1. Shutoff valves 2-inches and smaller shall be cast iron body gas cock, threaded ends; Crane No. 1228, Nibco or Stockham.
2. Shutoff valves greater than 2-inches shall be cast iron body gas cock, threaded ends; Crane No. 324, Nibco or Stockham.
3. For gas control and safety equipment see Section 15484.

PART 3 - EXECUTION

3.01 Installation

- (a) All valves and appurtenances shall be installed in the locations shown on the Drawings, true to alignment and properly supported. Any damage to the above items shall be repaired to the satisfaction of the Trust Representative before they are installed.
- (b) Install all of the various types of operators and appurtenances as shown on the Drawings, and install concrete inserts for supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and shall be responsible for the proper location of these valves and appurtenances during the construction of the structure.

3.02 Shop Painting

Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer.

3.03 Field Painting

All metal valves and appurtenances specified herein and exposed to view shall be painted.

END OF SECTION

SECTION 15101  
UTILITY PIPING SYSTEMS

PART 1 - GENERAL

1.01 Scope

- (a) Work specified in this Section is subject to the provisions of Division 1 and Section 15050.
- (b) The work covered by this Section includes furnishing all labor, equipment and materials required to furnish, install the utility piping systems as specified herein and/or shown on the Drawings.

1.02 References

- (a) Massachusetts State Building Code
- (b) Massachusetts State Plumbing and Gas Code
- (c) National Fuel Gas Code
- (d) National Fire Protection Association (NFPA) Standards
  - 1. NFPA 54                      National Fuel Gas Code
- (e) American Society for Testing and Materials (ASTM)
  - 1. A 53                      Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
  - 2. A120                      Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Use
- (f) Federal Specifications (FS)
  - 1. O-F-506                      Flux, Soldering: Paste and Liquid

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2. WW-N-351 Nipples, Pipe, Threaded
3. WW-P-521 Pipe Fittings, Flared Fittings, and Flanges; Steel and Malleable Iron (Threaded and Butt Welding) Class 150
4. WW-U-531 Unions, Pipe, Steel or Malleable Iron; Threaded Connection, 150 lb. and 250 lb.

(g) National Bureau of Standards (NBS)

1. Handbook H28

1.03 Submittals

- (a) Complete shop drawings and engineering data on all piping and accessories shall be submitted to the Trust Representative in accordance with the requirements of Section 01300 and Section 15050 of these Specifications.
- (b) Shop drawings shall indicate piping layout in plan and/or elevations as may be required and shall include a complete schedule of all pipe, fittings, specials, hangers and supports. Special coatings shall be clearly detailed showing all pertinent dimensions.
- (c) The Contractor shall furnish the Inspector with lists of all pieces of pipe, valves and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size and description of each item received.
- (d) Submit installation and maintenance instructions, and spare parts lists in accordance with Division 1 and Section 15050 of these Specifications.
- (e) The Contractor shall obtain approval for the proposed installation of natural gas systems from all local inspecting authorities that have jurisdiction prior to submittal to the Trust Representative.

1.04 Storage and Protection

- (a) Piping, valves and accessories shall be stored and protected in accordance with the requirements of the section entitled "General Equipment Stipulations" of these Specifications.

- (b) All piping and accessories shall be stored above ground and at a slope so as to be free-draining.

#### 1.05 Quality Assurance

- (a) The Contractor shall submit written evidence to the Trust Representative that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM or AWWA testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Trust Representative may require that the Contractor furnish test reports from an independent testing laboratory on samples of pipe materials.
- (b) Each pipe length, valve, and fitting shall be clearly marked with the pressure rating, metal thickness class, heat mark, net weight (excluding lining or coating) and name of the manufacturer.
- (c) Work shall be performed by workers skilled in the installation of utility piping systems.
- (d) Manufacturers of gas equipment shall be firms capable of showing at least five years of experience in the design and manufacture of natural gas equipment.
- (e) Coordinate the installation of each piping system with the work of other trades to avoid interferences.
- (f) Do not scale drawings.
- (g) Installation tools and equipment shall not damage products.
- (h) Coordinate natural gas service requirements with the local gas company for proper meter selection and installation.

## PART 2 - PRODUCTS

### 2.01 System Designation CS2 - Carbon Steel

- (a) Pipe: Black steel pipe, ASTM A 53 or A 120, Schedule 40, screwed
- (b) Fittings
  - 1. Non Potable Water: Malleable iron, ANSI/ASME B16.3, screwed
  - 2. Natural Gas System
    - a. Malleable iron, ASTM A 197, screwed end, 150 psig rated
    - b. Steel butt-weld or socket weld type fittings, Schedule 40
- (c) Valves: Refer to Section 15100.
- (d) Unions: Unions shall be the same material and working pressure as the fittings specified for the piping system. Unions on piping 2-1/2-inches in size and larger shall have a bolted flanged joint.

### 2.02 Piping Accessories

- (a) Pipe Sleeves: Pipe sleeves shall be provided where pipes pass through any concrete slabs.
- (b) Bolts and Nuts: Machined brass, stainless steel or galvanized carbon steel, and not smaller than 1/4-inch; bolts shall have hexagonal heads and nuts shall be hexagonal.
- (c) Solder for Solder-Jointed Tubing: 95 percent tin and 5 percent antimony flux shall be non-corrosive type conforming to FS-F-506.
- (d) Fittings that unite dissimilar metals shall be dielectric insulating type.

## PART 3 - EXECUTION

### 3.01 Installation

- (a) General: After pipes have been installed either cap or plug ends of pipes. Neither bury, furr-in, nor conceal piping before piping has been inspected and tested.

(b) Water Supply System (Non Potable)

1. Trenching: Section 02220, Earthwork
2. Cut pipe accurately to measurements established at worksite; work pipe into place without springing and forcing. Install pipe with a fall towards either shut-off valve or lowest fixture.
3. Remove fins and burrs from piping. Apply lubricant to male threads only; threads shall be full cut, and not more than three threads on pipe shall remain exposed after tightening. Coat installed and tested exposed ferrous threads with one coat of red lead and oil paint.
4. Install piping true to line and grade and support and guide in a manner which will ensure indicated alignment. Installed piping shall clear obstructions, preserve headroom, keep openings and passageways clear, and not be in same trenches as sewer lines. Install unions on pipe ends immediately adjacent to valves, equipment and tanks.
5. Valves shall be accessible for operation and servicing. Stems of installed valves shall not be below horizontal position.
6. Make-up soldered-to-threaded connections with male thread-to-solder adapters.

C. Natural Gas

1. Install and test all piping in accordance with NFPA 54 National Fuel Gas Code.
2. Installation scheduling of natural gas system components shall be coordinated with the building construction schedule to cause no delays in the execution of other portions of the construction Contract.
3. Underground pipe may be polyethylene gas piping, Type PE2306M in accordance with ASTM D2513.

### 3.02 Cleaning and Testing

Refer to Section 01666 of these Specifications.

### 3.03 Demonstration

- (a) The Contractor shall instruct the Trustee's personnel in the proper operation and maintenance of all piping systems components after final system testing is completed.
- (b) Provide written confirmation to the Trustee that all piping systems have been tested and are in satisfactory working order.

END OF SECTION

## SECTION 15190

### MECHANICAL IDENTIFICATION

#### PART 1 - GENERAL

##### 1.01 Requirements Included

- (a) Work specified in this Section is subject to the provisions of the section entitled "Basic Mechanical Requirements" of these Specifications.
- (b) Furnish and install markers, tags and nameplates for mechanical equipment, piping, controls, and valves to fully identify these items in reference to a master list.
- (c) Furnish a complete list of all equipment, piping, controls and valves with coordinated designations and locations for each device.

##### 1.02 References

- (a) American National Standards Institute (ANSI) Standards
  - 1. ANSI A13.1 Scheme for the Identification of Piping Systems

##### 1.03 Submittals

- (a) Submit product data in accordance with provisions of the section entitled "Shop Drawings, Product Data and Samples" of these Specifications.
- (b) Submit catalog cuts, product samples, installation instructions and any other information required to determine compliance with the Contract Documents.
- (c) Submit complete list of equipment, piping, controls and valves with identification codes and locations. Coordinate this list with the equipment identifications utilized in other sections of the Specifications and by the various trades involved in the work.

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#### 1.04 Quality Assurance

- (a) All materials of a similar type shall be the product of a single manufacturer.
- (b) Identification materials shall be manufactured by a company regularly producing this type of product. Materials used shall be specifically manufactured for identification purposes.
- (c) Acceptable Manufacturers of Identification Products
  - 1. W.H. Brady Company
  - 2. Seton Name Plate Corporation

#### 1.05 Sequencing and Scheduling

- (a) Coordinate installation of identification devices with the installation of the mechanical equipment.
- (b) Installation of identification devices may be done at the equipment manufacturer's factory.
- (c) Install identification devices prior to final testing and balancing of the mechanical systems.

### PART 2 - PRODUCTS

#### 2.01 Pipe Markers

- (a) Markers and direction-of-flow arrows for piping which will be accessible for maintenance shall be of semi-rigid plastic.
- (b) Letter sizing shall be manufacturer's standard, graduated in accordance to the pipe size.
- (c) Marker background color and letter color shall be coded to identify pipe contents in accordance with ANSI A13.1.

#### 2.02 Valve Markers

- (a) Provide 1-1/2-inch diameter polished brass markers, not less than 19 gauge thickness.
- (b) Letters shall be 1/4-inch high. Numbers shall be 1/2-inch high. Both letters and numbers shall be stamped and black-filled.

- (c) Valve marker fasteners shall be either meter seals, four-ply 18 gauge smooth copper wire, brass "S" hooks, or brass jack chain.
- (d) Markers shall bear indications corresponding to the notations on the framed wiring diagrams, control diagrams and operating instructions.

#### 2.03 Equipment Nameplates

- (a) Provide 2-1/2 x 3/4-inch aluminum nameplates with black enamel background and either etched or engraved lettering.
- (b) Provide corrosion-resistant fasteners.
- (c) Nameplates shall bear indications corresponding to the notations on the framed wiring diagrams, control diagrams and operating instructions.

#### 2.04 Control Nameplates

- (a) Provide laminated colored plastic nameplates with white lettering.
- (b) Each switch position shall be clearly indicated.
- (c) Word nameplates to identify the respective product and function.
- (d) Provide corrosion-resistant fasteners.

### PART 3 - EXECUTION

#### 3.01 Pipe Markers

- (a) Install adjacent to each valve and fitting.
- (b) Install at each pipe passage to underground.
- (c) Install on 25 foot centers on horizontal pipe runs.

#### 3.02 Valve Markers

Fasten to valve body in a manner which will facilitate being easily read.

#### 3.03 Equipment Nameplates

Mount securely to the appropriate piece of equipment.

### 3.04 Control Nameplates

Mount securely to the appropriate control device such that switch position and control function are easily read.

END OF SECTION

SECTION 15250  
MECHANICAL INSULATION

PART 1 - GENERAL

1.01 Requirements Included

- (a) Work specified in this Section is subject to the provisions of Section 15051.
- (b) Furnish and install thermal insulation for equipment and piping.
- (c) Furnish and install electrical heat tracing to the extent indicated in the Contract Documents.

1.02 References

National Fire Protection Agency (NFPA) Standards

- 1. NFPA 255 Method of Test of Surface Burning Characteristics of Building Materials

1.03 Quality Assurance

- (a) Insulation products shall have a Flame Spread Rating not exceeding 25 and Smoke Developed Rating not exceeding 50.
- (b) Installation shall be performed by workers skilled in the fitting and installation of insulation products.

1.04 Submittals

- (a) Submit product data in accordance with the provisions of Section 15051 and Division 1.
- (b) Submit catalog cuts, performance data, sealing tape, mastic and all other information required to demonstrate compliance with the Contract Documents.
- (c) Submit manufacturer's installation instructions.

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## PART 2 - PRODUCTS

### 2.01 Acceptable Manufacturers

Acceptable manufacturers of insulation products are CertainTeed, Knauf, Manville and Owens-Corning.

### 2.02 Equipment Installation

Materials: Equipment insulation shall be glass fiber board with factory applied foil-skrim-kraft vapor barrier. Thermal conductivity shall not exceed 0.25 BTU·in/h·ft<sup>2</sup>·F at 50 degrees F.

### 2.03 Pipe Insulation

#### (a) Materials

1. Premolded cellular glass thermal insulation in accordance with ASTM C552 fabricated for standard pipe sizes, fittings and valves.
2. Maximum thermal conductivity of 0.38 BTU·in/h·ft<sup>2</sup>·F at 70 degrees F in accordance with ASTM C177 and C518.
3. Maximum water vapor permeability of 0.00 perm-in when tested in accordance with ASTM E96.
4. Average density of 8.5 lb/ft<sup>3</sup>
5. Maximum Flame Spread Rating of 5 and Smoke-Developed Rating of 0 when tested in accordance with NFPA 255.
6. Utilize installation adhesives and joint sealants as recommended by the insulation manufacturer.
7. For piping above ground, install 24 gauge stainless steel jacketing over insulation retained by stainless steel bands. For piping underground, install PVC secondary containment over insulation.
8. Insulation products shall be equal to Pittsburgh Corning Foamglass.

(c) Description

1. Insulate all: Hide pile gas piping (HPG) and above grade nitrogen distribution piping.
2. Piping insulation thickness shall be 1-1/2-inches for pipes over 2-inches and up to 4-inches, and 2-inches for pipes over 4-inches.

2.04 Electric Heat Tracing

A. Self-Regulating Heat Tracing - Piping

1. 16 AWG copper bus wire with self-regulating, semi-conductive core
2. Tinned copper shield over bus wire and core
3. Modified polyolefin jacket over shield
4. Nominal wattage of 5 watts/foot at 50 degrees F
5. Nominal service voltage is 120 volts AC unless noted otherwise
6. Coordinate circuit sizing with available electrical circuits shown on the Electrical Drawings
7. Provide power connection kits, splice kits, end seals and other accessories required for a complete operating system. Electrical accessories shall be NEMA 4X rated.
8. Provide NEMA 4X thermostat on each heat trace circuit to sense pipe temperature and energize heat tracing below setpoint temperature.
9. Heat trace system shall be equal to Raychem Chemelex BTV-CR.
10. Provide aluminum tape under and over heater on FRP pipes to be heat traced.

## PART 3 - EXECUTION

### 3.01 Installation

- (a) Insulation shall be installed in accordance with manufacturer's recommendations.
- (b) Insulation butt joints shall be sealed with tape a minimum of 2-inches wide matching the character of the insulation vapor barrier.
- (c) Insulation bonding must be by glue, self-adhesive lap or tape. Staples are not permitted. Seal all vapor barrier punctures.
- (d) Surface to be insulated and insulation shall be clean and dry during installation.

### 3.02 Pipe Insulation

- (a) Pipe hangers shall be outside of the pipe insulation.
- (b) Install pipe insulation on exterior pipe to a depth at least as deep as the frost line (42-inches below grade).
- (c) Seal edges of pipe insulation with approved mastic to create a water and vapor proof seal.

### 3.03 Electric Heat Tracing

- (a) Install heat tracing in strict accordance with the manufacturer's instructions prior to insulation.
- (b) Spiral wrap heat tracing around pipe, valves, and fittings as required to attain wattage densities noted.
- (c) Provide additional wattage for valves and fittings in accordance with the manufacturer's instructions.
- (d) Secure heat trace cable to piping and components.
- (e) Coordinate heat trace installation with the electrical work.
- (f) Thermostat Setpoint Temperatures: 70 degrees F

- (g) Heat Trace Wattage Densities: Heat trace HIDE gas pile (HPG).

<u>Pipe Size, inches</u>	<u>Watts/Foot</u>
2 and smaller	5.0
3	5.6
6	11.2

- (h) Provide pipe markers cautioning "DO NOT CUT INSULATION - ELECTRIC HEAT TRACING - SHOCK HAZARD". Apply markers as specified in Section 15190 Mechanical Identification.

END OF SECTION



## SECTION 15300

### BELOW GRADE GAS COLLECTION SYSTEM

#### PART 1 - GENERAL

##### 1.01 Work Included

- (a) The specifications and accompanying drawings are intended to cover the provisions of all labor, material and equipment necessary for the complete Gas Collection System for the Industri-Plex Site Remedial Trust in Woburn, Mass. Any reference to a specific manufacturer is to establish a standard of quality. Substitution of equipment of equal or better quality is acceptable. It becomes the Contractors responsibility to coordinate, adjust, and install the new equipment in accordance with the manufacturers recommendations and workmanlike practices which includes notification of and coordination with the other trades on the project.
- (b) It is the intent and purpose of these specifications and accompanying drawings to cover and include under each item all materials, machinery, apparatus and labor necessary to properly install, equip, adjust and put into perfect operation the respective portions of the installation Specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- (c) Any equipment, apparatus, machinery, material and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of the installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications. This shall include all materials devices or methods peculiar to the machinery, equipment, apparatus or systems furnished and installed by this Contractor.

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## 1.02 Related Work Specified Elsewhere

- (a) Controls - Section 15950

## 1.03 Laws and Permits

- (a) This Contractor shall obtain all necessary permits or licenses, arrange for and run all tests on any or all parts of his work as may be required by State and/or local authorities. This trade shall perform all work in strict compliance with all laws, regulations and/or codes applying, including those of the Federal, State or Municipal; National Fire Protection Agency; BOCA, OSHA, and any other authority having jurisdiction, within requirements of these specifications. Four copies of all certificates and permits shall be submitted to the Trust Representative. All the associated fees for the above shall be paid by contractor.

## PART 2 - PRODUCTS

### 2.01 Materials and Equipment

- (a) All materials and equipment installed by this trade shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein.
- (b) All material and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with those published by the manufacturer and be in accord with engineering data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of ordering.
- (c) Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. This trade shall obtain these instructions from the manufacturer, and these instructions shall be considered part of these specifications. No experimental material or equipment shall be permitted.

## 2.02 Supports

- (a) The Contractor shall furnish and install all supports, including angles, channels and beams for the support of all equipment and piping installed under this contract. All piping shall be arranged to maintain the required pitch and provide for proper expansion and contraction.
- (b) All lines shall be rigidly and firmly installed to prevent swaying, vibrating and sagging. Piping supported from underneath and not subject to expansion shall have adjustable pipe saddle supports on properly sized pipe stanchions. Saddle supports shall be equal to Grinnell, figure 264 of Fee and Mason, figure 291. For piping running near floor, use brackets or pedestals, depending upon the space through which the pipe passes. Provide additional supports for heavy valves and specialties.
- (c) The use of pipe hooks, chains, or perforated metal straps for pipe supports will not be permitted.
- (d) The Contractor shall provide for supporting and guiding piping, structural supports consisting of channels, angles, etc., these being placed around the piping systems and attached to the existing structural members. At certain locations, channels and angle irons shall be installed in which pipe rollers shall be placed to support the piping.
- (e) All supports shall be teflon coated, minimum 5 mil.

## 2.03 Anchors

- (a) Anchors shall be constructed of structural steel, being continuously welded together and anchored to the structure.
- (b) Anchors shall suit the design of the structure at the place of anchoring.
- (c) Contractor shall submit detailed dimensioned drawings of the anchors to the Trust Representative for his approval.

## 2.04 Pipe and Fittings

- (a) All gas collection piping shall be as specified in the following schedule with manufacturer's standard symbol on each length.
- (b) All connections to equipment on piping shall be flanged, standard weight pattern, with face and gasket to match the equipment flange.
- (c) Type of piping to be installed for the various services shall be as specified in the following schedule:

### SYSTEM

### SCHEDULE

Gas Collection Piping

A

- (d) All valves shall be selected for not less than 150 psi or 150% of normal working pressure, whichever is greater.
- (e) All valves for this project shall be the product of one manufacturer when possible.

### SCHEDULE A

### COMPONENT

### DESCRIPTION

Pipe	All sizes 100 lb. Class vinyl ester resin filament wound fiberglass pipe in accordance with ASTM D2992-A and ASTM D2996-71.
Perforated Pipe	Same as above with 1/2" dia holes, 4" O.C. both sides 180 deg. apart.
Fittings	Compression molded vinyl ester resin base with min. 39% chopped glass fiber reinforcement.
Valves	Quarter turn butterfly valves damper style ANSI full face flat flanges, body-PVDF, disc-PVDF, seats and seals-vitron, pneumatic operator.
Gaskets	1/8" thick, 60-70 durometer, full face type suitable for the service.

## 2.05 Bidirectional Detonation Flame Arrestors

- (a) Arrestor housing - welded 316 stainless steel. Crimped metal arrestor element - 316 stainless steel in a stainless steel element housing. Arrestor shall be capable of quenching a flame front velocity of 5,800 ft/sec with pressures in excess of 500 psig. 150 # A.N.S.I. R.F. flanges. Flame arrestor shall be equal to Protectoseal series # 25000.

## 2.06 Polymerized Concrete Vaults

- (a) Underground enclosure shall be Composolite as manufactured by Quartite Corp. or equal. Enclosures and covers shall be gray color and rated for no less than 5,000 lbs. over a space 10" x 10" area and be designed and tested to temperatures of -50 deg F. Material compressive strength shall be no less than 9,000 psi. Provide locking cover and neoprene gasketing for watertight service. Provide a breather anti-flood valve mounted in one cover section for each vault as detailed on Sheet 15-2. Breather valve shall be an inverted foot valve with the screen on the opposite end. Material shall be PVC as manufactured by Hayward True Check type or approved equal.

## PART 3 - EXECUTION

### 3.01 Preparation

- (a) The Contractor shall work in conjunction with each of the other trades to facilitate proper and intelligent execution of work and with minimum of interference.
- (b) The Contractor shall carefully examine all mechanical drawings and shall be responsible for the proper fitting of all material and equipment as planned and without interference with other piping or equipment. Proper judgment shall be exercised to secure best possible space conditions throughout; to secure neat arrangements for piping, and conduit; and to overcome all local difficulties and interference to best advantage. Approval of any and all changes to plans and specifications shall be obtained from the Design Engineer before proceeding.

- (c) Carefully examine the specifications and drawings, visit the Site and fully inform themselves as to all existing conditions and limitations to be met.
- (d) Should any discrepancies occur between the existing conditions and the drawings and specifications, they shall be reported immediately to the Design Engineer for clarification.
- (e) This Contractor shall be responsible for delivery of equipment and shall unload and store same in a manner not to interfere with operations of other trades.
- (f) All work and methods of executing same under these specifications shall be completed in an approved first class workmanlike manner and shall conform to the best mechanical practice.
- (g) Before ordering any material or doing any work this trade shall verify all measurements at the building and Site, and shall be responsible for correctness of same. Any difference which may be found shall be submitted to Trust Representative for consideration before proceeding any further with the work.
- (h) This trade shall layout work and establish heights and grades for all lines, and equipment in strict accordance with the intent expressed by the drawings, and all the physical conditions and shall be responsible for the accuracy of the same.

### 3.02 Installation

- (a) Install all valves shown on the diagrams and specified herein without strain on the piping system.
- (b) All piping connecting to all other equipment shall be installed without strain at the connection to this equipment. All piping shall be clean before connecting to equipment.
- (c) All work, equipment and materials shall be protected at all times.

- (d) All piping openings shall be closed, with caps or plugs during installation. All equipment shall be tightly covered and protected against dirt, water, chemicals or mechanical injury during entire progress of installation. The Contractor shall make good all damage caused either directly or indirectly by his workmen.
- (e) All pipe connections shall be made so as to allow for perfect freedom of movement for piping during expansion and contraction, without springing or creating air pockets.
- (f) All piping shall be installed in the best workmanlike manner and in accordance with the best practices of the trade as shown on the drawings and required for the complete installation of the systems.
- (g) Piping shown on drawings show the general run and connections, Contractor shall be responsible for erecting the piping suitable in every respect for the work. Piping shall be installed so that access, clearance and pitch are maintained.
- (h) Contractors of the various trades shall coordinate the installation of materials and equipment to assure a smooth and uninterrupted flow of the project.
- (i) Keep all openings in pipes or fittings plugged or capped during installation.
- (j) Check drawings of the various trades so that piping will not interfere with equipment installation or other piping systems so that equipment can be serviced or replaced without excessive pipe removal.
- (k) Valves and specialties shall be so placed to permit easy operation and access. All valves shall be regulated, packed and adjusted before acceptance.
- (l) Should leaks develop in the various systems after they have been placed in operation, it shall be the responsibility of the Contractor to repair them

### 3.03 Joining of Pipe and Fittings

- (a) Cut and taper piping to be joined to fittings. Pipe and fittings shall be joined with vinyl ester adhesive using matching tapered coupling and spigot in accordance with ASTM D2310-71 & D2517-73.
- (b) All fittings used on the piping system shall be of an approved manufactured type, and tees and elbows shall be with wall thickness not less than the pipe.

### 3.04 Joining of Pipe and Vault

- (a) Cut and taper piping to be joined to vaults. Pipe and vaults shall be joined with vinyl ester adhesive using matching tapered cuts in accordance with ASTM D2310-71 & D2517-73.

### 3.05 Joining of Vault Segments

- (a) All joints of the assembled vaults shall be joined with vinyl ester epoxy resin adhesive in addition to joining adjacent vaults at all points of contact paying special attention to cut-outs and perimeter application. Vaults shall be made water tight.

### 3.06 Installing Underground Pipe

- (a) The final bedding of the trench must be uniform and continuous. Remove all sharp rocks and other abrasive material from the trench bottom. If the trench is excavated through rock or shale ledges, the trench must be slightly deeper and a layer of clean backfill used in the bottom of the trench and over the pipe to assure protection of the pipe from the rocks.
- (b) The installation shall be backfilled with sufficient fill to hold it in place with all of the fittings and joints left open for inspection during the testing period. Once the testing period is complete, then the backfilling may be finished. Use only clean backfill.



### 3.07 Operating Adjustments and Testing

- (a) The Contractor shall adjust each and every part of the new system and submit the necessary reports as required by the Trust Representative. All equipment must be adjusted so that no vibration or sound is transmitted to adjacent areas.
- (b) All piping systems shall be completely tested and proven tight for a period of twenty-four hours
- (c) Test all piping to a pressure of 150 psi or 1.5 times the operating pressure, whichever is greater, for a period of 12 hours.
- (d) Should leaks develop in any part of the piping systems, these defective sections, fittings, etc., must be removed and replaced as caulking with metal or compound will not be permitted.

END OF SECTION

## SECTION 15483

### WASTE GAS COMBUSTION FLARE SYSTEM

#### PART 1 - GENERAL

##### 1.01 Scope

Furnish and install waste gas combustion flare system of the size, type, capacity and characteristics described within the Contract Documents and shown on the Drawings, with components and appurtenances required for a safe, complete operating system.

##### 1.02 References

A. Underwriter's Laboratories (UL) Standards - UL Listed Label

1. UL 181 Factory Made Air Ducts and Connectors

(b) Factory Mutual (FM) System - FM Approval Label

(c) National Fire Protection Association (NFPA) Standards

1. NFPA 70 National Electrical Code
2. NFPA 54 National Fuel Gas Code
3. NFPA 82 Standard of Incinerators, Waste and Linen Handling Systems and Equipment.

(d) American Society for Testing and Materials (ASTM)

1. ASTM D 2992 Standard Method for Obtaining Hydrostatic Design Basis for Reinforced Thermosetting Resin Pipe (RTRP) and Fittings

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2. ASTM D 2996 Standard Specification for  
Filament Wound RTRP

3. ASTM E 84 Test Method for Surface  
Burning Characteristics of  
Building Materials

(e) American National Standards Institute (ANSI)

1. ANSI B16.52 Chemical Plant and Petroleum  
Pipe Code

(f) Massachusetts Fuel Gas Code, 1990

(g) BOCA National Mechanical Code, 1990

(h) BOCA National Fire Prevention Code, 1990

(i) Local Codes and Ordinances

#### 1.03 Quality Assurance

(a) All flare system components shall be provided and assembled into a complete operating system by a single manufacturer.

(b) All flare system components shall be factory mounted and pre-wired on a single equipment skid.

#### 1.04 Submittals

(a) Submit shop drawings and product data in accordance with Division 1 and Section 15051.

(b) Submit the following additional information:

1. Certified performance data for destruction efficiency at the design flow rate for the specified waste gas stream analysis.

2. Installation and start-up instructions.

3. Number of shipping packages and shipping dimensions

4. Equipment capacities

5. Utility requirements

6. Operating weight

## PART 2 - PRODUCTS

### 2.01 Acceptable Manufacturers

Acceptable manufacturers are NAO and McGill Environmental

### 2.02 Flare

- (a) Waste gas burner shall have a ANSI 150 pound raised face flanged waste gas connection. Burning capacity shall be not less than 9,000 SCFH gas of 0.60 specific gravity, at 13-inches W.C. inlet pressure. Gas stream to be burned shall have the following approximate analysis:
  - 1. Hydrogen Sulfide - 0.3 percent
  - 2. Trace Volatile Organics (benzene, toluene, dichlorobenzene, chlorobenzene, ethyl benzene) - 0.004 percent
  - 3. Methane 0-24 percent
  - 4. Remainder of gas will be composed of carbon dioxide with potential concentrations of air
  - 5. Gas stream may be saturated with moisture.
- (b) Utilities Available: Natural gas 1,000 BTU/CF, 10 psig, electricity 460 volts, 3 phase.
- (c) Gas burner shall be temperature and air controlled to provide up to 1,800 degrees F sustained internal combustion temperature when assisted with 10 psig natural gas. Destruction efficiency shall be 99 percent for hydrogen sulfide ( $H_2S$ ).
- (d) Automatically controlled electric air dampers shall be provided integral to the burner unit to admit combustion air and control combustion temperature by air quenching.
- (e) Burner shall be self supporting. Burner shall not require baffles, downdraft preventers, flame screens, or secondary stacks for flame stability. Pilot piping and stack chamber wall shall be carbon steel. Stack chamber refractory lining shall be low density ceramic rated for continuous operation up to 2,300 degrees F.
- (f) Pilot gas and waste gas stream shall be mixed and ignited at ground level within burner stack. Assist gas main and pilot valve and regulator package shall be mounted exterior to the combustion chamber in a non-hazardous location.

- (g) Continuous flame nozzle shall be mounted integral to burner and shall have long profile flame. Pilot shall be inclined off vertical. Pilot flame shall extend through waste gas flow profile to ensure ignition from low to high flow rates. Unprotected pilot shall withstand winds up to 100 mph. Pilot shall be capable of operating on natural gas supplied to venturi at 10 PSIG.
- (h) Waste gas burner head and integral end-of-line flame arrester shall be constructed of 316 stainless steel. Flame arrester shall be UL listed.
- (i) Provide four 4-inch diameter capped test ports mounted as indicated on the Drawings.
- (j) Automatic ignition system shall consist of the following components:
  - 1. Heavy wall 316 stainless steel continuous pilot nozzle which shall burn a stoichiometric air/gas mixture.
  - 2. Heavy wall 316 stainless steel thermowell with insulated thermocouple installed in combustion chamber.
  - 3. Assist gas burner with 316 stainless steel gas ring and flame retainers.
  - 4. Valve and regulator package for controlling assist main and pilot fuel gas. Package shall include isolation valves, pressure regulators, pressure gauges, and explosion proof solenoid valve. All components shall be copper free and installed on a mounting panel.
  - 5. Spark ignition pilot assembly shall include NEMA 7 enclosure, spark ignition transformer, spark plug, and pilot UV flame scanner. Gas inlet connection shall be NPT and shall be fitted with a flame check union. Solid state automatic ignition controller and spark generator mounted in a NEMA 7 enclosure. Controller shall have a single point electrical connection at 120 volt, single phase, pre-wired to the system transformer. Components shall be FM approved or UL listed.

(k) Control panel shall be mounted in NEMA 4X enclosure and shall include the following features:

1. PLC programmed by flare manufacturer with all safety interlocks.
2. Pilot flame monitoring by UV scanning.
2. Status lights for Solenoid Valve Position, Ignition On, Pilot On, and Flame Failure.
3. Adjustable combustion chamber thermocouple setpoint controller.
4. Interlocks shall include low/high water seal levels, pilot flame failure, and high unit temperature.
5. Manual ignite button.
6. SPDT contacts for remote indication of Pilot On/Off and System Alarm functions.
7. Capability for repeated ignition cycle.
8. Provision for remote start upon receipt of 4-20 ma DC signal.
9. Controller enclosure heater with thermostat.
10. Combustion air damper controller.
11. Assist main gas controller.
12. Audio-visual alarm on top of enclosure.
13. Combination starters and disconnect switches for gas booster blowers.
14. Main overcurrent protective device.
15. Numbered terminal strip for future outputs.

(l) Continuous Emissions Monitoring Systems (CEMS) shall consist of the following:

1. H<sub>2</sub>S total reduced sulfur analyzer.
2. Free standing NEMA 4X enclosure with air conditioner and heater.

3. Open hastelloy sample probe with overboard calibration.
  4. Fully automatic sample conditioner with automatic calibration, sample line blowback, T.E. chiller, heated sample pump, continuous condensate drain, low flow and moisture breakthrough sensor/alarms, and a heated pyrex inertial separator. Calibration frequency shall be as a minimum configurable to once daily, or per latest USEPA requirements.
  5. Data acquisition system for self-diagnostics and data manipulation. System to include connections to a remote computer, hard drive, keyboard, CRT display, printer and software capable of providing reports for hourly and daily summaries, calibration drift and exceedance alarm logs. Minimum scan time for sampled inputs shall be once per minute, or per the latest USEPA requirements.
  6. 4-20 mA isolated output.
  7. Upon H<sub>2</sub>S detection the control system shall alarm at annunciators and provide alarm contact to control system (by others).
  8. Numbered terminal strip for future outputs.
- (m) A single point connection shall be provided for 460 volt, 3 phase power. All required transformers and low voltage power supplies shall be provided and pre-wired. A minimum of 72 hours of emergency power shall be provided for orderly shutdown of the PLC without program or setpoint loss and activation of the audio-visual alarm and remote alarm outputs. All system components shall be interlocked and pre-wired.

## 2.03 Flare Accessories

### (a) Valves

1. Provide gas butterfly valves as indicated on the Drawings and as specified in Section 15920 of these Specifications.
2. Provide nonpotable water and gas valves as indicated on the Drawings and specified in Section 15100 of these Specifications.

3. Provide an IRI/FM approved gas train as indicated on the Drawings.
4. Provide gas safety and control equipment as indicated on the Drawings and specified in Section 15484 of these Specifications.
5. Provide all instrumentation indicated on the Process and Instrumentation Flow Diagram, Layout Drawings, and specified herein.

(b) Water Seal

1. Provide carbon steel water seal tank with 1/8-inch corrosion allowance. Tank shall be factory primed and have a finish coat of white epoxy paint.
2. Provide with 3-inch 150 pounds ANSI RF FS flanged gas inlet and outlet connections, 1-inch IPS water fill with mechanical float and valve, handway with cover plate, liquid level switch connections with high and low level float type liquid level switches, 2-inch IPS drain with valve, level gauge, skimmer outlet with spring return safety valve, and plugged sample connection on downstream side of water seal. Provide with pressure relief and flame trap. Low and high level switches shall be interlocked with the control panel.

(c) Water Seal Storage Tank

1. Provide a water tank to serve the water seal. The tank shall have a minimum capacity of 55 gallons. Tank and supports shall be factory primed and have a finish coat of white epoxy paint.
2. Provide with steel mounting supports and mount at an elevation above or equal to the water seal water fill connection.
3. Provide with low level switch interlocked with the control panel, 1-inch IPS drain with valve, vent to atmosphere, and fill connection.



4. Water used in the water seal and the storage tank shall be mixed with ethylene glycol for cold climate protection in a proportion of 50 percent water and 50 percent glycol.
- (d) Gas Booster Blowers (HP-F-1A and HP-F-1B): Provide two high pressure gas booster blowers, each blower shall be as described below:
1. 150 SCFM
  2. 7-1/2 HP maximum
  3. 40-inch W.G. (minimum total pressure)
  4. 460 volt, 3 phase, 60 Hz
  5. Stainless steel, sparkproof, Class A construction
  6. TEFC motor (explosion proof), 1.15 Service Factor
  7. Weather cover
  8. The gas booster blowers shall be fully assembled and shop run tested.
  9. Variable Speed Drive
    - a. Type: Input diode bridge full wave rectifier and output inverter capable of producing a constant volts per hertz variable frequency pulse width modulated output suitable for operating a standard squirrel cage induction motor. Drive shall be two circuit board design with logic components on one board and power components on the other.
    - b. Ratings
      - (1) Speed Range: 6 to 60 Hertz with a variable torque load.
      - (2) Efficiency: 95 percent minimum at 100 percent speed.
      - (3) Service Factor: 1.0 continuous; 1.5 for one minute.
      - (4) Speed Regulation: 3 percent.
    - c. Equip drive with adjustments for minimum speed, maximum speed,

acceleration-deceleration rate and current limit.

d. Protective Features

- (1) Input molded case circuit breaker rated 22,000 AIC to disconnect the drive and control circuits.
- (2) Output contactor to disconnect the motor when the drive is off. Interlock contactor with drive to prevent starting unless the drive is at zero volts and hertz. Provide restart delay to allow equipment to coast to rest before restarting. Output contactor may be rated in accordance with NEMA or IEC standards.
- (3) Solid state protective circuits with diagnostic capabilities for over/under voltage, loss of voltage, inverse time and instantaneous overcurrent, phase loss, phase unbalance, and thermal overload. Activation of all protective functions shall be accomplished without damage to the drive and without need to replace any components. Over/under voltage and loss of voltage are to reset automatically when voltage returns to normal; all other conditions are to be manually reset.
- (4) Provide protective circuitry, if not inherent in the drive design, to shut down without damage to the drive if an out of synch condition occurs (i.e. running drive connected to a stopped motor, plug reversal or motor stall).
- (5) Where motor temperature switches are specified, provide circuitry to shut down the drive if the switch opens.

e. Input Voltage and Phase: 480 volt, three phase.

f. Enclosure: Free standing. Enclosure shall meet NEMA 4 requirements.

10. Equip motors with heavy, self-aligning, sealed ball bearings rated for a B-10 life of 100,000 hours, fitted with pressure lubrication fittings.

(e) Piping

1. Fiberglass Reinforced Piping (FRP)

- a. Pipe shall be manufactured by a filament winding process using a thermosetting epoxy resin to impregnate strands of continuous glass filaments which are wound around a mandrel at a prescribed helix angle and under controlled tension. All pipe shall be supplied with a matching tapered integral bell and tapered spigot or tapered coupling and a matching tapered spigot.
- b. Piping shall be rated for 225 psig (minimum) at 225 degrees F (minimum) in accordance with ASTM D 2992 - Procedure A.
- c. Piping shall have continuous glass fiber filament wound at a 35-1/4 degree helix angle in a matrix of epoxy resin. Pipe shall be in compliance with ASTM D 2996 and classified by its designation code. Pipe shall meet all dimensional and performance requirements and mechanical properties.
- d. Pipe shall be filament wound over two layers of epoxy resin saturated surfacing veil liner with final nominal liner thickness of 30 mils. Glass to resin ratio for the liner shall be 85 percent resin by weight minimum.
- e. Flanges shall be flat-faced and drilled in accordance with ANSI B16.5, Class 150, bolt hole standards. Flanges shall be compression molded with a minimum of 45 percent chopped glass fiber, or filament wound.

- f. Compression molded fittings shall be manufactured using an epoxy molding compound. The molding compound shall be reinforced with a minimum 45 percent chopped glass fiber. In-line fittings are filament wound.
- g. Fabricated fittings shall be manufactured using pipe filament wound at a helix angle of 35-1/4 degrees which has been meter cut and bonded together. The bonded segments shall be reinforced by hand-laying glass cloth impregnated with epoxy resin. Additional reinforcement shall be provided by a spray-up process using resin and randomly oriented chopped glass fibers.
- h. Gaskets shall be 1/8-inch thick, 60-70 durometer, full face type suitable for the service.
- i. Adhesive and curing agents shall be epoxy.
- j. Pipe and fittings will be joined with epoxy adhesive using matching tapered bell/coupling and spigot.
- k. Install piping in accordance with the manufacturer's recommendations.
- l. Support pipe as indicated on the Drawings, and in accordance with Section 15094 of these Specifications and the manufacturer's recommendations.
- m. Clean and test piping in accordance with Section 01666 of these Specifications.
- n. Piping shall contain waste gas only.
- o. Piping shall be suitable for outdoor application.
- p. Flame spread shall be less than 25 as determined by ASTM E-84.

- q. Flanged Connections: Flanges shall meet ANSI B16.5, Class 150 bolt hole standards. Gasketing materials shall be full face, 1/8-inch thick with a Shore A hardness of 60 to 70 durometer. Gaskets made from teflon and FVC are not acceptable.
- 2. Carbon Steel Piping (CS2): See Section 15101 - Process and Utility Piping Systems of these Specifications.
- 3. Insulation and heat tracing of FRP piping shall be applied and installed in accordance with Section 15250 of these Specifications.

(f) Instrumentation

- 1. All provided field and panel mounted instruments shall be in accordance with the Instrument Society of America (ISA) recommended practices.
- 2. All devices shall be industrialized in nature, no primary HVAC devices shall be allowed.
- 3. All control valves, relief valves and flowmeters shall be provided with detailed sizing calculations to ensure their proper application to the particular function.
- 4. The following list of suggested vendors provides a guideline for quality of the equipment to be provided with the system. A detailed Bill of Materials shall be submitted with the proposal.
  - a. Control Valves: Fisher
  - b. Regulators: Fisher
  - c. Level Switches: Magnetrol
  - d. Pressure Switches: Ashcroft
  - e. Pressure Gauges: Ashcroft, Chemical Duty, 4-1/2-inch
  - f. Solenoid Valves: ASCO
  - g. Pressure Relief, High Pressure: Crosby
  - h. Pressure Relief, Low Pressure: Protectoseal
  - i. Thermocouples: By Vendor
  - j. Panel Controllers: Moore Products, Honeywell
  - k. Analytical Systems: By Vendor
  - l. Gas Flowmeters: By Vendor

m. Programmable Controllers: Modicon,  
Allen Bradley

5. A unit specification sheet, in accordance with ISA SP-20 shall be provided with each instrument. Each device must have its own stainless steel tag permanently attached to the device.

#### 2.04 Sequence of Operation

(a) Ignition Sequence: On receipt of manual start or remote start signal the following occurs:

1. Water seal level switches shall be open; either closure shall lock out system.
2. Prepurge cycle of minimum of 30 seconds to remove gases from combustion chamber.
3. Pilot solenoid opens and gas is ignited by spark ignitor. Repeated ignition tries will lock out system. Pilot ignition shall be proved by UV flame scanner.
4. Main assist gas valve is opened by controller to ignition by pilot. Main assist gas shall be proved by UV flame scanner.
5. Combustion chamber is heated until thermocouple setpoint is satisfied.
6. Waste gas valve is opened by controller for combustion of waste gas stream.

(b) Combustion Temperature Control

1. Chamber temperature minimum and high limit temperature shall be detected by thermocouple. Thermocouple signal shall allow controller to open air inlet damper for prefire heating of chamber and quenching when temperature setpoint is exceeded. High unit temperature shall lock out system.
2. Main assist gas valve shall be modulated to provide gas to maintain unit setpoint.

(c) Gas Booster Blower Sequence

1. Auto start sequence shall be initiated.
2. Waste gas valve shall open.
3. On confirmation that waste gas valve is opened, primary blower shall start and ramp up to PIC output.
4. If, after preset time primary blower does not start, secondary blower shall start and ramp up to PIC.
5. If after preset time secondary blower does not start, the system shall initiate safety shutdown sequence.
6. The suction pressure is maintained by a PIC controller operating from the absolute pressure transmitter (PIT). The controller output varies the blower suction pressure through the blower variable frequency drive.

(d) Shutdown Sequence: Manual or remote start signal is disengaged or safety interlock tripped:

1. Waste gas valve closes and blower stops.
2. Main assist gas valve closes.
3. Pilot gas solenoid closes.
4. Automatic air damper opened by controller for a minimum of one minute to purge combustion chamber.

(c) Relief Gas Valve: Upon unit shutdown, the relief gas valve shall open; when the unit is activated, the relief gas valve shall close.

2.05 Equipment Insulation and Finishes

- (a) Equipment shall be factory-insulated and finished as described herein and in Section 15250 in the locations shown on the Drawings or otherwise described in these Specifications.
- (b) Factory and field-applied finishes shall be compatible with the service application for the protection of the equipment.

### PART 3 - EXECUTION

#### 3.01 General

- (a) Manufacturer's representative shall be present at and provide a minimum of two days assistance at system start-up.
- (b) Provide operation and maintenance instruction to Trustee's personnel.

#### 3.02 Installation

- (a) Install in accordance with manufacturer's recommendations, Contract Documents, Codes and Ordinances.
- (b) Add 50 percent ethylene glycol to water seal and water seal storage tanks in accordance with the manufacturer's recommendations.

#### 3.03 Testing

The entire system shall be factory run tested before delivery to the job site.

END OF SECTION



## SECTION 15484

### GAS SAFETY AND CONTROL EQUIPMENT

#### PART 1 - GENERAL

##### 1.01 Scope

- (a) This section covers all piping, fittings, valves and accessories for natural, manufactured or waste gas handling exclusive of service entrance pressure regulation and piping and valving of gas-using appliances.
- (b) Furnish all labor, materials, equipment and incidentals required to complete and make ready all appurtenances as shown on the Drawings and as specified herein.
- (c) The equipment shall include, but is not necessarily limited to, the following:
  - 1. Flame Arrester
  - 2. Flame Checks
  - 3. Relief Valve and Flame Trap Units
  - 4. Explosion Relief Valves
  - 5. Pressure Regulators
- (d) Work included elsewhere:
  - 1. Natural Gas System
  - 2. Waste Gas Combustion Flare System

##### 1.02 Related Requirements

Section 15483 - Waste Gas Combustion Flare System

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### 1.03 Quality Assurance

- (a) All products shall be new and of first quality.
- (b) All products shall have all surfaces in contact with the flowing medium to be corrosion-resistant.
- (c) Installation of gas safety equipment shall be compliant with the following:
  - 1. National Fire Protection Association (NFPA) Standards:
    - a. 54-87 National Fuel Gas Code
    - b. 70-90 National Electric Code
    - c. 328-82 Flammable Liquids and Gases in Manholes, Sewers
  - 2. Massachusetts State Fuel Gas and Plumbing Code
  - 3. Local Codes and Ordinances

## PART 2 - PRODUCTS

### 2.01 Gas Safety Equipment

- (a) Flame Arrester Unit
  - 1. Flame arrester shall have flanged connections. Flow capacity shall be 330 SCFH for natural gas of 0.60 specific gravity.
  - 2. Net free area through flame arrester bank assembly shall not be less than four times the corresponding size standard pipe. Housing shall be off-set with a 1/2-inch NPT drain connection at the low point. Entire bank assembly shall slide easily out of the arrester housing to facilitate inspection and cleaning. It shall not require support for alignment, and shall not place a strain on connecting piping. Bank frame shall be extensible, and shall be filled with corrugated rectangular shaped bank sheets. Sheets shall be arranged for individual removal. Flame arrester for vertical installation shall be self-draining. Flame arrester for horizontal installation shall include an offset housing with a 1/2-inch NPT drain connection at the low point.

3. Flame arrester housing shall be constructed of 367 HT low copper cast aluminum. Bank assembly shall include a low copper aluminum frame with 316 stainless steel bank sheets.
4. Flame arrester unit shall be manufactured by Varec.

(b) Flame Checks

1. Flame checks shall have NPT connections. Flow capacity shall be 45 SCFH for natural gas of 0.60 specific gravity at 1.5-inch W.C. pressure drop. Housing shall be of "pipe union" design to permit easy disassembly for inspection and cleaning. Element shall be replaceable and be made of compressed woven wire. Housing shall be constructed of low copper 356 HT cast aluminum. Element shall be 316 stainless steel. Maximum working pressure shall be 25 psig.
2. Flame check shall be manufactured by Varec.

(c) Pressure Relief and Flame Trap Assembly

1. Pressure relief and flame trap assembly shall have ANSI 125 pound flat face flanged connections. Valve shall be set to relieve at 18-inches W.C. pressure and 150 cfm capacity for hide pile gas at 0.60 at 2-inch W.C. pressure increase above setting.
2. The pressure relief device shall be a single port back pressure regulator. Regulator valve shall be controlled by a large, spring loaded diaphragm. Regulator shall provide tight shut-off. It shall maintain a back pressure within approximately 10 percent of the setting. The spring barrel shall include a glass enclosed pointer and scale to indicate setting. A spring adjusting screw shall permit setting adjustments without disassembling the diaphragm housing. Setting range shall be from 12-inches to 32-inches W.C. pressure.

3. Construction shall be 356 HT low copper cast aluminum body, diaphragm and spring housings, and diaphragm plate. Inner valve shall include low copper aluminum pallet with 304 stainless steel stem and bushings. Diaphragm shall be molded Buna-N rubber with nylon reinforcement. Setting spring shall be zinc plated steel. Adjusting screw shall be 304 stainless steel.
4. Net free area through flame arrester bank assembly shall not be less than four (4) times the corresponding size standard pipe. Housing shall be off-set with a 1/2-inch NPT drain connection at the low point. Entire bank assembly shall slide easily out of the arrester housing to facilitate inspection and cleaning. It shall not require support for alignment, and shall not place a strain on connecting piping. Bank frame shall be extensible, and shall be filled with corrugated rectangular shaped bank sheets. Sheets shall be arranged for individual removal.
5. Flame arrester housing shall be constructed of 356 HT low copper cast aluminum. Bank assembly shall include a low copper aluminum frame with 316 stainless steel bank sheets.
6. Regulator and flame arrester shall be functionally interconnected by a thermally actuated by-pass valve. It shall be the spring actuated double-acting needle valve type. By-pass valve shall operate within 15 seconds when the fusible element reaches 260 degrees F.
7. By-pass valve shall automatically close the regulator by applying full upstream gas pressure on the top side of the diaphragm housing. It shall be designed so it does not shut off gas flow unless fusewell is contacted by flame. Fusible element shall be replaceable without disassembling the valve. By-pass valve assembly shall be constructed of aluminum and stainless steel with Buna-N "O" rings.
8. Regulator, flame arrester, and by-pass valve shall be factory assembled as a single unit. Assembly shall be leak proof to 5 psig.

9. Relief valve and flame arrester unit shall be manufactured by Varec.

(d) Explosion Relief Valves

1. Pressure (explosion) relief valve shall have an ANSI 125 pound flat face flanged connection. Pressure relief shall be set at a pressure and capacity as scheduled for gas at 0.60 specific gravity.
2. Pallet assembly shall be dead weight loaded. It shall incorporate a replaceable synthetic rubber seat insert. Valve shall include removable lead weights for adjusting setting from 4 to 12-inches W.C. in 1-inch increments. Valve shall have an extended neck between flange and seat ring. Seat ring shall be replaceable. A protective screen shall be provided at the pressure port, located external of the pallet.
3. Construction shall include 356 HT low copper aluminum valve body and seat ring. Pallet assembly, hood, and guide posts shall be low copper aluminum. Seat insert shall be neoprene. Explosion relief valve shall be manufactured by Varec.

2.02 Gas Control Equipment

(a) Pressure Regulators

1. Gas main pressure regulator shall have ductile iron body, aluminum trim, screwed NPT connections, internal relief, 1/8-inch port, and 5-20 psig spring range. Pressure regulator shall be Fisher Type 627R-641 or approved equal.
2. Gas pilot pressure regulator shall have ductile iron body, aluminum trim, screwed NPT connections, internal relief, 3/32-inch port, and 5-20 psig spring range. Pressure regulator shall be Fisher Type 627R-351 or approved equal.

PART 3 - EXECUTION

3.01 Installation

- (a) Installation shall be workmanlike in all respects.
- (b) Piping dope or tape shall be compatible with the medium flowing through the pipe and equipment.
- (c) Testing of all safety equipment shall be conducted with air at the design conditions.

END OF SECTION

SECTION 15920  
GAS BUTTERFLY VALVES

PART 1 - GENERAL

1.01 Scope

- (a) Work specified in this Section is subject to the provisions of Division 1 and Section 15050.
- (b) Furnish and install air butterfly valves of the size, type, and characteristics described within the Contract Documents.

1.02 Related Requirements

Section 15483 - Waste Gas Combustion Flare System

1.03 References

- (a) American Society for Testing and Materials (ASTM) Standards
  - 1. ASTM C 581; Test for Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures
  - 2. ASTM C 582; Specifications for Reinforced Plastic Laminates for Self Supporting Structures for Use in a Chemical Environment
  - 3. ASTM D 638; Test for Tensile Properties of Plastics
  - 4. ASTM D 790; Test for Flexural Properties of Plastics
  - 5. ASTM D 2563; Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
  - 6. ASTM D 2583; Test for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

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7. ASTM D 2584; Test for Ignition Loss of Cured Reinforced Resins

(b) American National Standards Institute (ANSI) Standards

1. ANSI/ASME B16.5; Pipe Flanges and Flanged Fittings

#### 1.04 Submittals

Submit product data in accordance with the provisions of Division 1 and Section 15051.

### PART 2 - PRODUCTS

#### 2.01 Air butterfly Valves (3, 4, 6, 8 and 10-inches)

- (a) Provide plastic air butterfly valves suitable for use in wet airstreams containing hydrogen sulfide ( $H_2S$ ), methane, and trace amounts volatile organic compounds including of benzene, toluene, dichlorobenzene, chlorobenzene, and ethylbenzene.
- (b) Provide valves with single piece bodies with flange hole characteristics meeting ANSI Class 125/150 dimensions.
- (c) Valve Construction
  - 1. 30 percent glass reinforced polypropylene lens butterfly disc and shaft bearings
  - 2. PVC body, end plug, and seal retainers
  - 3. Viton liner, moisture seal, and draft O-rings
  - 4. Type 416 stainless steel valve stem
  - 5. Type 316 stainless steel retainer ring
- (d) Valves shall be bubble tight construction.
- (e) Valves shall be manufactured by Hayward Industrial Products or George Fisher.



## 2.02 Manual Operators

- (a) Provide corrosion resistant 304 stainless steel operators by valve manufacturer.
- (b) Provide lever operators for 3 and 4-inch valves.
- (c) Provide gear operators for 6-inch valves.

## 2.03 Electric Operators

- (a) Provide NEMA 4X electric operator by valve manufacturer.
- (b) Operator Construction
  - 1. Manual override
  - 2. Two limit switches
  - 3. Open/closed feedback
  - 4. Operator located outdoor shall have 120 volt, single phase heater to control condensation.
- (c) Provide valve with handwheel for manual stroke.

## PART 3 - EXECUTION

### 3.01 Installation

- (a) Install valves in accordance with manufacturers recommendations.
- (b) All valves and appurtenances shall be installed in the locations shown on the Drawings, true to alignment and properly supported. Any damage to the above items shall be repaired to the satisfaction of the Trust Representative before they are installed.
- (c) Install valves between duct flanges with 316 stainless steel bolts, nuts and washers.
- (d) Support pipe at both sides of each valve in a manner that allows removal of valve for maintenance without temporary pipe support.

END OF SECTION

## SECTION 15960

### CONTROLS

#### PART 1 - GENERAL

##### 1.01 Work Included

- (a) The specifications and accompanying drawings are intended to cover the provisions of all labor, material and equipment necessary for the complete Gas Collection System for the Industri-Plex Site Remedial Trust in Woburn, Mass. Any reference to a specific manufacturer is to establish a standard of quality. Substitution of equipment of equal or better quality is acceptable. It becomes the contractors responsibility to coordinate, adjust, and install the new equipment in accordance with the manufactures recommendations and workman like practices which includes notification of and coordination with the other trades on the project.
- (b) Furnish and install elements for complete functioning systems, services and equipment as later specified under this DIVISION of the complete specifications and/or as indicated on the drawings.

##### 1.02 Submittals

- (a) Submittals are required for the following:
  - 1. Pressure sensor and controller
  - 2. Pressure regulators.
  - 3. Pneumatic valve actuator with positioner
  - 4. Nitrogen gas generator
  - 5. Compressor
  - 6. After Cooler

##### 1.03 Codes and Regulations

- (a) Comply with the latest editions of following works, including all supplements thereto and any other authority having jurisdiction within requirements of this specification.

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1. Local Codes.
2. National Fire Protection Association NFPA
3. O.S.H.A.
4. BOCA Code.

- (b) Whenever drawings or specifications require materials, workmanship, arrangement or construction of higher standard or larger size than is required by codes and regulations - drawings and specifications shall take precedence.
- (c) Should there be direct conflict between above-mentioned regulations and Drawings or Specifications, Contractor shall refer the matter to the Design Engineer.

## PART 2 - PRODUCTS

### 2.01 Nitrogen Gas Generator

- (a) The Nitrogen Gas Generator, supplied as a packaged unit as manufactured by Balston Model #75-75, shall be complete with an oil and solids removal perfilter, a 0.01 millimeter membrane final filter, automatic drains, moisture indicator, a line pressure regulator on the discharge line adjustable from 70 to 125 psi outlet with max input of 250 psi. A two year supply of perfilter cartridges shall be furnished. The generator shall be capable of supplying 99% pure nitrogen @ 100 psig. Entire unit shall be heat traced and insulated with materials as specified in section 15250. All enclosures shall be NEMA 4x.

### 2.02 Aftercooler

- (a) The Aftercooler shall be fan powered-air cooler capable of providing a 5°F approach to ambient when supplied with 6.7 SCFM of compressed air at 250°F. Constructed of copper tubing, aluminum fins and rigid steel compressed air connections enclosed in metallic gray steel cabinets with automatic drain. Unit shall be Dayton Model #32739, 1/2 hp 110V, single phase, provided with line voltage thermostat and remote strap on sensor. Sensor shall be strapped onto discharge air line under insulation. All enclosures shall be NEMA 4X.

### 2.03 Compressor

- (a) Compressor shall be oil-less type duplex simultaneous operation as manufactured by ITT Pneumotive model #EP-2B-D120-50-200/60/3. Complete with 120 gal receiver and electrical control panel with magnetic starters, heaters, low voltage transformers, control circuit and automatic tank drain. Unit shall be capable of providing 15.2 SCFM of compressed air at 100 psig. All enclosures shall be NEMA 4x.

### 2.04 Raceways

- (a) Rigid nonmetallic conduit ( Vinyl ester resin Fiberglass schedule 40 ) shall be used underground Class I.
- (b) Do not install conduit which has been crushed or deformed in any way.
- (c) Cap or plug conduit ends as soon as possible after installation and let remain so until just before installation of tubing.

### 2.05 Hangers, Supports, Etc.

- (a) Use only special devices specifically designed and manufactured for hanging and support of conduit as manufactured by Appleton Electric Co., Steel City Electric Co., Thomas & Betts Co., or F&S Mfg. Corp., Unistruct, or approved equal.

### 2.06 Tubing

- (a) Dynalon vinyl plastic tubing, non toxic, chemical resistant, clear and inert, S.G. 1.2, tensile strength 2000psi, temp. range -40 deg C to 212 deg F, industrial grade.

### 2.07 Above Ground Piping

- (a) All above ground piping for compressed air service shall be black steel schedule 40.

### 2.08 Pressure Regulator - 100 to 20 lb

- (a) Air set with drip well for filtering and reducing pressurized air. Supply air max 250 psi. Outlet pressure adjustable from 0 to 25 psi. 1/4" NPT connections, high efficiency filter element down to 5 microns

## 2.09 Air Operated Controllers

- (a) Air operated controller - indicating - 2 to 100% proportional band. Cast aluminum case, gasketed for dust, vapors waterproof with external setting adjustment knob for adjustment of control index.
- (b) 30" Vac. to 0" pressure monitoring range.
- (c) Pressure activated sensor and tubing system shall be furnished in all stainless steel construction with heliarc welds. Reference pressure atmospheric, operating pressure - 4" W.C. Vacuum.
- (d) Output range - 0 to 20 psi, Input air 20 psi.
- (e) Reference of quality Trerice P87700T

## 2.10 Pneumatic Actuators

- (a) For operation of butterfly valves. Air supply pressure 80 psi, Double rack and pinion actuator with self-lubricating carbon filled teflon bearings. Air to spring failsafe to open. Corrosion resistant Rilsan coating inside and out. Actuator shaft series 303 stainless steel. Pneumatic positioner for modulating control - 3 to 15 psi signal with 15 psi full closed, 3 psi full open, actuator and positioner as manufactured by Kinetrol, Dallas, Texas.

## 2.11 Nameplates

- (a) Provide nameplates for all control equipment, engraved brass or engraved lamacoid; riveted in place, in accordance with Schedules. Nameplates shall be one inch high with 1/2" lettering of length of lettering plus 1/2" each side.

## PART 3 - EXECUTION

### 3.01 Preparation

- (a) Before installation, all piping, valves, fittings, and other components for all nonflammable nitrogen gas systems shall be thoroughly cleaned of oil, grease, and other readily oxidizable materials as if for oxygen service. After cleaning, particular care shall be exercised in the storage and handling of such material. Such material shall be temporarily capped or plugged to prevent recontamination before final assembly. Just prior to final assembly, such material shall be examined internally for contamination and shall be recleaned if necessary.

- (b) Piping, valves, fittings, and other components prepared at the job site shall be cleaned by washing in a hot alkaline cleaner-water solution, such as sodium carbonate or trisodium phosphate. Scrubbing shall be employed where necessary to ensure complete cleaning. After washing, the materials shall be thoroughly rinsed in clean, hot water.
- (c) All installations shall be in accordance with NFPA99, 4-4.1.4

### 3.02 Installation - General

- (a) Do not consider drawings as merely diagrammatic; make no major divisions from indicated or herein described method of installation except in cases where unforeseen obstructions are encountered.
- (b) Examine and study all Structural and Mechanical drawings; particularly note wall construction and become thoroughly acquainted with conditions affecting installation of all conduits and other work.

### 3.03 Special Trustee Instruction

- (a) Upon completion of installation, manufacturer for each piece of equipment shall provide complete set of shop drawings, operated instructions, maintenance data, parts list, etc. for Trustee. Neatly secure these within binder. Do not present loose sheets.
- (b) Manufacturer's Representative shall present binders to Trust Representative: then check his equipment for wiring, rotation and proper operation, and demonstrate its operation, maintenance care and emergency procedures to Trust Representative.
- (c) Manufacturer's Representative shall forward written affidavit to Trust Representative, certifying that inspections, and demonstrations called for, have been made.

### 3.04 Final Tests

- (a) Prior to the turning over of work as complete unit, test all components installed under this contract for proper connections, leaks, and binding restrictions. Conduct tests with aid of suitable testing instruments, and in presence of Trust Representative.

END OF SECTION

## SECTION 16000

### ELECTRICAL POWER AND SYSTEMS

#### PART 1 - GENERAL

##### 1.01 Scope

- (a) The electrical work commences with the point of electrical service where shown on the Drawings and includes furnishing all material and labor for a complete electrical installation.
- (b) The requirements of Division 1 apply to all work hereunder. The General and Special Conditions are a part of this Division of the Specifications and all provisions contained therein which affect this work are as binding as though incorporated herein.

##### 1.02 Definitions

- (a) Provide: Furnish, install, and connect.
- (b) Product Data: Catalog cuts and descriptive literature.
- (c) Shop Drawings: Factory prepared specific to the installation.
- (d) Indicated: Shown on the Drawings.
- (e) Noted: Indicated or specified elsewhere.

##### 1.03 Material Not Furnished

- (a) Unless otherwise noted, the following are furnished and installed under other Divisions:
  - 1. Motors
  - 2. Motor starters (except motor control centers)
  - 3. Electrical heat tracing
  - 4. Pilot and control devices for the above equipment

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Power wiring and equipment connections for the above items are included in this Division. Also included in this Division is control wiring to the extent shown on the Electrical Drawings; other control wiring is furnished under the applicable Mechanical Division.

#### 1.04 Local Conditions

Power will be supplied by the utility company overhead distribution system. Verify and comply with all power company requirements for metering. Make necessary arrangements with the power company for temporary service requirements. Have the power company review submittals on equipment containing utility metering sections.

#### 1.05 Quality Assurance

- (a) Provide the complete electrical installation in accordance with the 1990 National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.
- (b) All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.
- (c) Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the Project.
  - 1. American National Standards Institute (ANSI)
  - 2. American Society for Testing and Materials (ASTM)
  - 3. Federal Specifications (FS)
  - 4. Institute of Electrical and Electronics Engineers (IEEE)
  - 5. Insulated Cable Engineers Association (ICEA)
  - 6. National Electrical Manufacturers Association (NEMA)
  - 7. National Fire Protection Association (NFPA)



## 8. Underwriters Laboratories, Inc. (UL)

### 1.06 Submittals

- (a) Approval drawings consist of shop drawings, product data and other information as noted in the individual equipment sections. Except as noted, submittal information is for approval and equipment may not be installed until submittals have been returned with stamped approval.
- (b) Information required "for reference" such as product samples, similar unit test reports and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned and stamped approval is not required prior to installation.
- (c) Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

### 1.07 Record Drawings

- (a) Furnish record drawings in accordance with the requirements of Section 01720. Record drawings consist of submittal data as listed above, operation and maintenance data, and as-built drawings. Record drawings are to reflect the final installation, including any changes during approval, manufacturing tests, and installation.
- (b) In addition to other required sets, furnish one set of operation and maintenance data for all apparatus requiring service. This set is to be bound in hardback, 3-ring binder(s) and shall include:
  - 1. Title page with project name; installing contractor's name, address and telephone number; date of installation and warranty period.
  - 2. Index sheet.
  - 3. Complete manufacturer's operation and maintenance data with tabs (corresponding to the index) separating each item or system. Include the name, address, and phone number

of the nearest sales and service organization for each item.

- (c) As-Built Drawings: Furnish one set of prints maintained at the job site at all times with all changes during construction marked thereon. Include on the as-built drawings sufficient dimensions to permit location of underground conduits.
- (d) Submit the results of any tests required in the individual equipment sections.

#### 1.08 Delivery, Storage and Handling

- (a) Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.
- (b) Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

### PART 2 - PRODUCTS

#### 2.01 Materials

Provide only new products of the manufacturer's latest design.

#### 2.02 Substitutions

Where the words "equal to" follow or precede the listed acceptable manufacturers, equal products of other manufacturers are acceptable and request for substitution may be made during submittal stage.

## PART 3 - EXECUTION

### 3.01 Installation

- (a) The complete installation is to be accomplished by skilled electrical tradesmen, with certified or suitably qualified individuals performing all special systems installation and testing. All workmanship shall be of the highest quality, sub-standard work will be rejected.
- (b) Schedule the work and cooperate with all trades to avoid delays, interferences, and unnecessary work. If any conflicts occur necessitating departures from the Drawings and Specifications, details of departures and reasons therefore shall be submitted immediately for the Trust Representative's consideration.

### 3.02 Certification and Tests

- (a) Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.
- (b) At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.
- (c) After final review and acceptance, turn over to the Trustee all keys for electrical equipment locks. Present to the Trustee or the Trustee's designated representative, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

## SECTION 16050

### BASIC ELECTRICAL MATERIAL AND METHODS

#### PART 1 - GENERAL

##### 1.01 Work Included

This Section includes basic materials and methods common to all Sections of Division 16.

##### 1.02 Submittals

Submit product data.

#### PART 2 - PRODUCTS

##### 2.01 Conduit

- (a) Rigid Steel Conduit: ANSI C80.1; minimum size 3/4-inch.
- (b) Intermediate Metal Conduit (IMC): UL 1242; minimum size 3/4-inch.
- (c) Flexible Metal Conduit: FS WW-C-566.
- (d) Couplings, Fittings and Conduit Bodies: NEMA FB-1; threaded for rigid steel and IMC; squeeze type for flexible metal conduits.

##### 2.02 Conductors

- (a) Building Wire: NEMA WC-5; Copper, 75/90 degree C; type THWN/THHN; minimum size #12 AWG.
- (b) Control Wire: Same as Building Wire except minimum size #14 AWG.

##### 2.03 Boxes

Cast Boxes: Galvanized with gasketed cover and threaded hubs.

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#### 2.04 Wiring Devices

- (a) Switches: FS W-S-896, 20 amp, 120-277 volt, ivory handle.
- (b) Receptacles: NEMA WD-1; 5-15R; nylon face; ivory. Exceptions: Provide specific use receptacles where indicated. Provide 5-20R receptacles for branch circuits serving one device.
- (c) Cover Plates: Galvanized steel, gasketed, weatherproof where indicated.

#### 2.05 Disconnect Switches

- (a) Disconnect Switches: UL-98 and NEMA KS-1; 600 volt; heavy duty; quick make, quick break type; horsepower and I<sup>2</sup>t rated. Provide lever type operating handle directly connected to the switch mechanism; rocker types are not acceptable. Include padlocking provisions and nameplate clearly indicating "ON" and "OFF" positions. Equip all switches with a ground lug and, where neutral conductors are scheduled, provide insulated neutral lugs.
- (b) Fusible Switches: Equip with rejection clips for fuse types noted.
- (c) Enclosure: Glass reinforced polyester meeting NEMA 12 requirements.
- (d) Acceptable Manufacturers: Cutler-Hammer, General Electric, Square D or Westinghouse.

#### 2.06 Fuses

- (a) Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class J for ratings 600 amp and below and Class L for ratings 601 amp and above.
- (b) Acceptable Manufacturers: Bussmann, Chase-Shawmut or Littelfuse.

#### 2.07 Supporting Devices

- (a) Support Channel: Galvanized or painted steel.
- (b) Hardware: Corrosion resistant.

## 2.08 Electrical Identification

- (a) Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- (b) Wire and Cable Markers: Plastic, split sleeve or tubing type.

## PART 3 - EXECUTION

### 3.01 Conduit

- (a) Unless otherwise noted, use only rigid steel or IMC conduits.
- (b) Provide flexible metal conduit for connections to motors, transformers and other vibrating equipment.
- (c) Use suitable equipment for all bends. Crushed or deformed conduits may not be installed. Cut threaded ends square and ream to remove burrs. Paint threads with zinc compound.
- (d) Run exposed conduits parallel or perpendicular to building surfaces. Route conduits in slabs below top reinforcing and above bottom reinforcing. Coordinate with other trades and avoid hot piping when possible. Where unavoidable maintain 3 inches clearance when crossing and 12-inches clearance when paralleling hot pipes. Cap exposed conduit ends during construction.
- (e) Conduits left empty for future use, telephone wiring, etc. shall have a 200 pound tensile strength polyolefin line pulled through and tied off at each end.
- (f) All connections are to be wrench tightened and electrically continuous. No running threads are permitted. Provide supports as required by NEC and, otherwise, within 3 feet of each box, cabinet, or fitting and at least every 10 feet. Provide clamp backs for all raceways on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

### 3.02 Conductors and Connectors

- (a) Use only stranded conductors. Exceptions: Solid conductors may be used for receptacle branch circuit wiring, sizes #10 and #12 AWG only.

- (b) Use 90 degree C insulated conductors for all lighting circuits. Use 75 degree C insulated conductors elsewhere, unless Drawings note otherwise.
- (c) Do not pull conductors until the conduit system is complete. Swab conduits prior to pulling and use pulling compound for all pulls. Do not exceed the manufacturer's pulling tension.
- (d) Avoid all unnecessary splices. Where unavoidable, make splices in outlet boxes or pull boxes.
- (e) Identify all conductors throughout the electrical system. For control and signal circuit, use numbered wire markers at all terminals. For power circuits color code per NEC.
- (f) Make connections to circuit breakers, disconnect switches, panel mains, etc. with solderless lugs. Use mechanical connectors for stranded conductors.

### 3.03 Boxes

- (a) Provide boxes as shown on the Drawings and as required for splices, taps, wire pulling and equipment connections. Support boxes independently of conduit. Provide knockout closures for unused openings.
- (b) Box locations shown on the Drawings are approximate unless dimensioned. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes and other furnishings. Locate outlet boxes to permit handicap access per ANSI A117.1. Where receptacles are indicated 18-inches above finished floor, dimension is to the bottom of the box. At the option of the Trust representative, any outlet may be relocated by up to 10 feet before it is permanently installed, without incurring additional cost. Install adjacent devices at the same elevation in a common box with one face plate. Install adjacent devices at different elevations in one vertical line.
- (c) Provide cast outlet boxes in exposed, exterior and wet locations.
- (d) Field drill conduit holes in tap, junction and pull boxes so as to afford the maximum bending radius for the conductors.

### 3.04 Wiring Devices

Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes. Install receptacles with ground pole down.

### 3.05 Disconnect Switches

- (a) Provide switches with voltage, ampere, and number of poles as indicated on the Drawings.
- (b) Switches are non-fused type, unless Drawings note otherwise, or the switch is used as a disconnect for an item of equipment with a maximum fuse size designated on the nameplate. In such cases, provide fusible type with appropriate fuse. If fusible switches protect conductors with an ampacity less than the rating of the switch, provide a nameplate on the inside front cover of the switch designating the maximum allowable fusing.
- (c) Install switches so they are rigidly supported and readily accessible. Provide stainless steel mounting channel or phenolic spacers to give nominal 1/2-inch separation from concrete walls in wet or damp locations.

### 3.06 Fuses

Equip all fusible devices with fuses. Replace all blown fuses up to final acceptance of the Project. At the completion of the Project, turn over to the Trustee spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

### 3.07 Supporting Devices

- (a) Fasten hangar rods, support stands, conduit clamps, etc. to building structure using expansion anchors or beam clamps.
- (b) Do not fasten supports to piping, ductwork, mechanical equipment or conduit. Do not use powder actuated fastening devices. Do not drill structural steel members.



### 3.08 Electrial Identification

Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters and other items of electrical distribution equipment. Engrave with the equipment identification as indicated; and the voltage, current and interrupting rating. Attach nameplates with screws or rivets; adhesives are not acceptable.

END OF SECTION

## SECTION 16461

### DRY TYPE TRANSFORMERS

#### PART 1 - GENERAL

##### 1.01 Work Included

Dry type two winding transformers.

##### 1.02 Submittals

Submit product data. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

##### 1.03 Delivery, Storage and Handling

- (a) Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- (b) Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

#### PART 2 - PRODUCTS

##### 2.01 Acceptable Manufacturers

- (a) General Electric
- (b) Hevi-Duty
- (c) I.T.E.
- (d) Sorgel
- (e) Westinghouse.

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## 2.02 Dry Type Transformers

- (a) Dry Type Transformers: NEMA ST-20; factory-assembled, air cooled dry type transformers; ratings as indicated. Transformers are two winding power type. Three phase units are connected delta primary and wye secondary. Scott or Tee connections and autotransformers are not acceptable.
- (b) Insulation: 220 degrees C, 150 degree C rise for ratings 30 kVA and larger; 185 degrees C, 115 degree C rise for ratings below 30 kVA.
- (c) Taps: Two, 5 percent below rated primary for ratings 15 kVA and smaller; six, 2-1/2 percent two above and four below rated primary for ratings larger than 15 kVA.
- (d) Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- (e) Mounting: Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be suitable for floor or trapeze mounting.
- (f) Isolate core and coil from enclosure using vibration-absorbing mounts.

## PART 3 - EXECUTION

### 3.01 Installation

- (a) Set transformer plumb and level.
- (b) Use flexible conduit, two foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

### 3.02 Field Quality Control

- (a) Check for damage and tight connections prior to energizing transformer.
- (b) Measure secondary voltage under normal load conditions and make appropriate tap adjustments.

END OF SECTION

## SECTION 16470

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.01 Work Included

Panelboards.

##### 1.02 Submittals

Submit shop drawings.

#### PART 2 - PRODUCTS

##### 2.01 Acceptable Manufacturers

- (a) General Electric
- (b) Square D
- (c) Westinghouse

##### 2.02 Panelboards

- (a) Panelboards: NEMA PB-1; UL 67.
- (b) Rating: Voltage and ampere ratings are shown on the Drawings. Unless otherwise indicated interrupting ratings (RMS symmetrical) are 14,000 amps for 480 volt panelboards and 10,000 amps for 240 and 208 volt panelboards.
- (c) Boxes: Code gauge galvanized steel meeting NEMA 3R requirements; sized to accommodate devices indicated and afford wire bending space in accordance with NEC requirements.
- (d) Fronts: Surface or flush as indicated, door-in-door construction, finished in light grey enamel over a rust inhibitor. Furnish flush lock for fronts less than 48-inches high and vault type handle with three point catch for fronts 48-inches and higher. Key all locks alike.

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- (e) Bus: Copper, ~~arranged for bolt-on circuit breakers.~~ Furnish insulated neutral bus and ground bus with main lug bonded to ~~chassis~~ ~~and~~ ~~and~~.
- (f) Circuit Breakers: ~~NEMA AB-1; molded case type,~~ thermal-magnetic ~~with internal common trip on~~ multipole breakers. ~~Provide breaker fully rated for~~ interrupting ratings ~~in the~~ series ratings are not acceptable. ~~ings noted: series ra~~
- (g) Provide engraved nameplates giving the voltage rating and panel designations as indicated. Provide a UL service entrance label for panelboards used as service entrance equipment. ~~for panelboards as~~

### PART 3 - EXECUTION

#### PART 3 - EXECUTION 3.01 Installation

- (a) Install boxes so they are rigidly supported and correctly aligned by ~~select mounting height~~ so that operating handles are not higher than 6 feet 6-inches nor lower than 24-inches above the floor.
- (b) Prior to energizing panelboards clean out construction dirt and debris; ~~remove any scratches on the trims or~~ dead front barriers. ~~Tag each phase to phase and~~ ground to insure that no short circuits exist.
- (c) Adjust panel barriers so that no openings occur between them and the panel front. ~~Provide filler plates and~~ plugs as necessary to maintain dead front integrity.
- (d) Type directory cards with circuit loads and/or area served. ~~Note space circuits in pencil.~~

#### 3.02 Field Quality Control

Measure steady state load currents at each panelboard feeders. ~~Should the difference at any panelboard between~~ phases ~~exceeds 20 percent, rearrange~~ circuits in the panelboard to balance the phase loads within 20 percent. ~~Take care to maintain proper phasing for multi-wire branch~~ circuits. ~~Take care to maintain proper phasing for mu~~ circuits.

END OF SECTION.

OF SECTION